SACRAMENTO RIVER FLOOD CONTROL PROJECT, CALIFORNIA
MID-VALLEY AREA, PHASE III

DESIGN MEMORANDUM
VOLUME II OF II

US Army Corps of Engineers

Sacramento District
South Pacific Division

August 1995

TO: Defense Technical Information Center
ATTN: DTIC-O
8725 John J. Kingman Road, Suite 0944
Fort Belvoir VA 22060-6218

27 July 2004

FROM: US Army Corps of Engineers, Sacramento District
Technical Library
1325 J Street, Suite 820
Sacramento CA 95814-2292

SUBJECT: Submission of Technical Reports for inclusion in Technical Reports Database

The enclosed documents are hereby submitted for inclusion in DTIC's technical reports database. The following is a list of documents included in this shipment.

1. Little Dell Lake, Salt Lake City Streams, Utah, Embankment Criteria and Performance Report, August 1994
2. Caliente Creek Stream Group Investigation California, Draft Feasibility Report, June 1987
3. Fanchier Creek Dam Fresno, California, Embankment Criteria and Performance Report, July 1994
4. Sacramento Metropolitan Area California: Final Feasibility Report and Final Environmental Impact Statement/Final Environmental Impact Report, February 1992
5. Geologic and Seismologic Investigation, Hidden and Buchanan Dams, Hensley Lake and Eastman Lake, Fresno and Chowchilla Rivers, California, December 1988
6. Sacramento River Flood Control Project, California, Mid-Valley Area, Phase III, Design Memorandum, Volumes 1 and 2, August 1995
7. Reconnaissance Report Yolo Bypass, California, March 1992
8. Provo and Vicinity, Utah, General Investigation Reconnaissance Report, April 1997
9. Sacramento-San Joaquin Delta, California, Draft Feasibility Report and Draft Environmental Impact Statement, October 1982

The **distribution statement is A** approved for public release; distribution is unlimited.

The Sacramento District source code is **410637**. Please return any materials that aren't appropriate for the technical reports database. Mailing label enclosed.

If you need assistance, please contact the undersigned at 916-557-6660.

Frances J. Sweeney
Sacramento District Technical Library
Frances.J.Sweeney@usace.army.mil

VOLUME II

DESIGN MEMORANDUM, VOLUME II

APPENDIXES

APPENDICES

APPENDIX A

STATE OF CALIFORNIA—RESOURCES AGENCY
GEORGE DEUKMEJIAN, *Governor*

THE RECLAMATION BOARD
1416 Ninth Street, Room 455-6
Sacramento, CA 95814
(916) 445-9454

APR 5 1990

Colonel Jack A. Le Cuyer
District Engineer
Sacramento District
U. S. Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814-4794

Dear Colonel Le Cuyer:

This letter is to inform you that The Reclamation Board intends to act as the nonfederal sponsor for Phases Two through Five of the Sacramento River Flood Control System Evaluation. The Board authorized this sponsorship at its February 16, 1990, meeting.

Nonfederal costs will be shared between the State and appropriate local agencies in accordance with the Water Code. The State's fiscal participation is, of course, subject to the appropriation of funds by the Legislature.

If you have any questions, please contact me at the above address or have your staff call Pete Rabbon at (916) 445-8984.

Sincerely,

for Arnold W. Johnson
RAYMOND E. BARSCH
General Manager

APPENDIX B

RESPONSE TO HQUSACE TECHNICAL COMMENTS
INITIAL APPRAISAL REPORT (IAR)

Sacramento River Flood Control System Evaluation
Phase III, Mid-Valley Area

1. References:

a. CESPK-PM-C Memorandum dated 17 January 1992, with CECW-EP-W 2nd endorsement dated 28 October 1992, Subject as above, copy attached. (Enclosure 1)

b. CECW-EP-W Memorandum 27 January 1993, Subject as above, copy attached. (Enclosure 2)

2. The comments received with reference 1. a & b (Encl. 1 & 2) have been evaluated and the appropriate comments incorporated in the Design Memorandum (DM). Below is our specific response to the comments: (The letters/numbers correspond with the IAR)

A. General Comment: Complied. Has been incorporated in DM.

B. Engineering Division Comments:

1. & 2. Complied. See Hydrology Report in the DM.

3. Complied. See figure 31 and Plate 3.

4. Complied. Will be incorporated in the Plan & Specification.

C. Planning and Policy Division Comments:

1. Complied.

2. Complied. The Cost Estimate has been updated in DM.

D. Programs Division Comments:

1. Complied. The required Mitigation Planting Design is synopsized in the DM, Chapter 6, and described in detail in Appendix E.

2. Complied. The Cost Estimate for Real Estate has been broken into four areas to establish the requirements for the economically justified project requirement. See Appendix F.

RESPONSE TO HQUSACE TECHNICAL COMMENTS
INITIAL APPRAISAL REPORT (IAR)

Sacramento River Floor Control System Evaluation
Phase III, Mid-Valley Area

E. Project Management Division Comments:

1. Complied. See Appendix G in the DM.

2. Complied

F. Real Estate Directorate Comment:

1. Complied, it is synopsized in the DM, Chapter 6, and described in detail in Appendix E.

CECW-EP-W(CESPK-PM-C/17 Jan 92) (1150) 2nd End
PEARRE/tf/(202) 504-4531
SUBJECT: Sacramento River Flood Control System Evaluation, Initial Appraisal Report - Mid Valley Area

28 OCT 1992

HQ, U.S. Army Corps of Engineers, Washington, D.C. 20314-1000

FOR Commander, South Pacific Division, ATTN: CESPD-ED-TC

1. The subject Initial Appraisal Report (IAR) is approved with comment. The attached technical comments (enclosure 3) should be answered in the Design Memorandum (DM) for Phase III.

2. A Limited Reevaluation Report (LRR) shall be prepared to present an economic analysis of the total project benefits and costs, in accordance with the forthcoming Fiscal Year 1993 work allowance instructions. The LRR will be submitted to CECW-PW for review and approval. The attached economic comments (enclosure 4) should be answered in the LRR.

3. The Phase III IAR will serve as the decision document for budgeting a Phase III construction new start. The LRR will serve to support the Project Cooperation Agreement (PCA) for Phase III and the each of the remaining phases. The DM for the phase will accompany the individual PCA's.

4. Once the LRR is approved, the documentation for the remaining phases shall consist of an IAR, as the budgetary decision document, and a DM, as the technical document, for the phase. Since the LRR will present an economic analysis based on the total project benefits and costs neither the IAR nor the DM for future phases will need to include an economics section.

5. The district may initiate engineering and design efforts towards preparation of the DM and Plans and Specifications using Construction General (CG) funds. A separate request for CG funds should be submitted to CECW-BW.

6. The Engineering Division POC for this action is Mr. Charles Pearre, CECW-EP-W, (202) 504-4531.

FOR THE DIRECTOR OF CIVIL WORKS:

4 Encls
wd encls 1-2
Added 2 Encls

PAUL D. BARBER, P.E.
Chief, Engineering Division
Directorate of Civil Works

CF: CECW-LM
CECW-BW
CECW-PW

Encl 1

CESPD-ED-TC (CESPK-PM-C/17 Jan 92) (1150) 1st End Ueda/5-1430
SUBJECT: Sacramento River Flood Control System Evaluation, Initial Appraisal Report - Mid Valley Area

DA, South Pacific Division, Corps of Engineers, 630 Sansome St. Room 720, San Francisco, CA 94111-2206 10 APR 1992

FOR CDR USACE, 20 Massachusetts Avenue, NW, WASH DC 20314-1000

1. Enclosed are 10 copies of the approved Mid-Valley Initial Appraisal Report (IAR) for your review and approval. As stated in the basic memorandum, two of the four flood areas evaluated are economically justified based on incremental analysis.

2. Also, request approval to use Construction General (CG) Funds following HQUSACE review of the IAR, and pending approval of the IAR, to initiate engineering and design efforts towards preparation of the technical document that will accompany the LCA to OASA-CW.

2 Encl
wd 5 copies encl 1

Roger F. Yankoupe
ROGER F. YANKOUPE
Brigadier General, U.S. Army
Commanding

CF:
CECW-E

Encl 1

HQUSACE TECHNICAL COMMENTS
INITIAL APPRAISAL REPORT (IAR) - MID-VALLEY AREA
SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION

A. GENERAL COMMENT: General Content of IAR: The IAR is satisfactory for budgetary decision purposes. Basic guidance on the requirements for this levee reconstruction effort was provided by ASA(CW) memorandum dated 23 March 1989, subject: Levee Reconstruction - Sacramento Urban Area. Subsequent guidance was appropriately cited in the IAR and should also be addressed in the Design Memorandum (DM).

B. ENGINEERING DIVISION COMMENTS:

1. General Comment of Project Interaction: The results of the hydraulics and hydrology (H&H) studies shown in the IAR may not accurately predict the results of the more complete studies to be done in conjunction with the American River/Sacramento Metropolitan Area Preconstruction Engineering and Design (PED) studies due to project interaction. After those PED studies are completed, levee reaches not scheduled for reconstruction, because of findings in the IAR could show up as threatened; and similarly, reconstructed levee sections may not be able to pass the design flood. The district should provide assurances in the project DM that these possible future levee threats will be covered in future levee raise projects now under study, or explain why this potential problem need not be addressed.

2. Current Levee Condition: The project DM should address why the Sacramento River Flood Control Project is unable to convey the design discharge. The discussion should include maintenance, original H&H models, original data base and elevation data, sedimentation in relationship to the original design, and any other information pertinent to the project's ability to convey the design discharge.

3. Table 3, Page 33, and Table 4, Page 52: Provide a map and maps showing the location of the sites listed in these tables in relationship to project features.

4. Future Monitoring: We agree with the statement on page 76 concerning future efforts concentrating on monitoring. Therefore, the DM should contain a discussion and costs for a long term surveillance plan.

HQUSACE TECHNICAL COMMENTS - INITIAL APPRAISAL REPORT (IAR) - MID-VALLEY AREA - SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION

C. PLANNING AND POLICY DIVISION COMMENTS:

1. Pages 73 and 98: The term deficient freeboard should be deleted from the report. The project is considered a reconstruction and not a deficiency since a determination of a deficiency has not been considered.

2. Page 108: The cost estimate should be updated to current price levels. Since the historic preservation costs for mitigation and data recovery are not cost shared, they should be shown below the adjusted subtotal for flood control. Therefore, the five percent cash amount will decrease.

D. PROGRAMS DIVISION COMMENTS:

1. Mitigation Requirements: The requirement for mitigation provided in Section 13 of Attachment C is questioned for the reasons listed in the following subparagraphs. It appears the project is mitigating for impacts that are not reasonably foreseeable, in view of the administrative guidance. The DM should fully address the requirement for mitigation.

a. The mitigation is redundant to the mitigation provided in the project area by the Yolo Basin Wetlands project that was circulated for HQUSACE review during May 1992.

b. The mitigation is based upon maximum impacts of a gross project estimate, while the reconstruction effort by definition should have minimal project construction impacts.

c. It is not clear how the mitigation relates to the economic concerns of the unjustified areas, but seemingly adds to the further costs of the elements that should not be included based upon the above cited guidance.

2. Real Estate Costs: The cost estimate includes $3,000,000 in non-Federal real estate costs. This requirement appears excessive in view of the traditional easements and rights-of-way for the basic project. Show the breakout of costs to the component areas of interest to establish the requirements for the economically justified project requirements.

HQUSACE TECHNICAL COMMENTS - INITIAL APPRAISAL REPORT (IAR) - MID-VALLEY AREA - SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION

E. PROJECT MANAGEMENT DIVISION COMMENTS:

1. Cost Estimates: The basis of the cost estimate on page 108 is not identified. True M-CASES estimates should be used to support estimates in the DM.

2. Project Management Plan (PMP): ER 5-7-1 requires that a PMP be prepared for any project in construction with five or more year remaining. If a PMP has not been done, one should be prepared addressing the full project (all five phases).

F. REAL ESTATE DIRECTORATE COMMENT: It was difficult to determine the adequacy and accuracy of the real estate information provided in the IAR. Some real estate matters are briefly discussed in the text; and while a Real Estate Estimate is provided, its cost figures are not explained. The DM should have a detailed Real Estate Section showing acreage and estates. A breakdown of the Real Estate Estimate should also be included.

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-EP-W 27 January 1993

MEMORANDUM FOR Commander, South Pacific Division,
ATTN: CESPD-ED-TC

SUBJECT: Sacramento River Flood Control System Evaluation, Initial Appraisal Report - Mid Valley Area

1. Reference memorandum CESPK-PM-C, 17 January 1992, with 2nd endorsement CECW-EP-W, dated 28 October 1992, subject as above.

2. The purpose of this memorandum is to revise (replace) the guidance previously provided in paragraphs 3 and 4 of the second endorsement to the above reference.

3. The Phase III IAR will serve as the decision document for budgeting a Phase III construction new start. The Design Memorandum (DM) prepared for Phase III shall include all formulation and economics analysis sections required for a General Design Memorandum (GDM). The economics presented in the DM shall be based on an incremental analysis of each section within the phase. This DM will receive a full Washington level review and will be used to support the Project Cooperation Agreement (PCA) for Phase III.

4. The documentation for the remaining phases shall consist of an IAR, as the budgetary decision document, and a DM with GDM level formulation and economics, as the technical document, for the phase. A copy of the approved LRR showing the total project benefits should accompany each IAR and DM and may be referenced in the documents.

5. The Engineering Division POC for this action is Mr. Charles Pearre, CECW-EP-W, (202) 504-4531.

FOR THE DIRECTOR OF CIVIL WORKS:

Paul D. Barber

PAUL D. BARBER, P.E.
Chief, Engineering Division
Directorate of Civil Works

CF: CECW-LM
CECW-BW
CECW-PW

Encl 2

APPENDIX C

BASIS OF DESIGN

GEOTECHNICAL EVALUATION OF LEVEES
FOR THE
MID-VALLEY AREA, PHASE III

October 1994

PREPARED BY

SOIL DESIGN SECTION, GEOTECHNICAL BRANCH

U.S. ARMY ENGINEER DISTRICT, SACRAMENTO

CORPS OF ENGINEERS

BASIS OF DESIGN
GEOTECHNICAL EVALUATION OF LEVEES
FOR THE
MID-VALLEY AREA, PHASE III

TABLE OF CONTENTS

PAGE (cont.)

TABLES

FIGURES

BASIS OF DESIGN

GEOTECHNICAL EVALUATION OF LEVEES
FOR THE
MID-VALLEY AREA, PHASE III

A. INTRODUCTION

This study was performed for the purpose of determining the final geotechnical recommendations for levee repairs in the Mid-Valley study area. The Mid-Valley study area is one of five phases in the Sacramento River Flood Control System Evaluation. The Mid-Valley Study Area includes approximately 350 miles of flood control levees as shown in Figure 1. In general, the levees within the study area have performed well. There have been relatively few cases of levee slumping and foundation piping and only isolated reports of complete levee failure. However, some of the reaches which have experienced instability or foundation piping in the past are considered a potential threat to the integrity of the system. This basis of design focuses primarily on the reported problem sites that were identified in the December 1991 Initial Appraisal Report (ref. 1, Appendix B). Following further evaluation, structural remediation is recommended at several sites. The conclusions and recommendations are based on review of geotechnical reports (references 1 through 4), review of office files of problem areas, site inspections, interviews with local representatives, additional explorations, laboratory testing, and seepage and stability analyses at various sites.

Twenty-nine sites identified in this study are considered the "weakest links." These sites are summarized in Tables 1 and 2 and schematic repair recommendations are shown on Figure 33. The lengths of repairs may be modified slightly during final site layout prior to construction. Remediation of these sites will significantly reduce the risk of levee failure during future high river stages. However, it must be recognized that remediation of these repairs is not a panacea. There is no guarantee against future levee damage or failures. The levee and foundation soil conditions are extremely variable. The levees were constructed during various periods with an assortment of soil types and construction techniques. The explorations have not necessarily detected all possible latent weaknesses in the levee system. The only way to have a high degree of certainty that structural problems will never occur is to reinforce entire levee reaches using structural modifications such as slurry cutoff walls or landside stability berms. Additionally, the levees are not in a static condition. Surface erosion, excessive animal activity (squirrel holes), irrigation ditches located too close to the levee landside toe, undetected erosion of the foundation, buried pipes, decomposing vegetation, and continual weathering of certain types of levee soils all affect future levee reliability. It is therefore essential that continual monitoring and maintenance as necessary be given high priority by the various maintaining agencies.

B. PREVIOUS STUDIES

The initial phase of investigation in the Mid-Valley study area was performed by Roger Foott Associates in 1989 (ref. 2). That study included a compilation and review of all available geotechnical data in the study area, explorations and laboratory testing, and an assessment and

preliminary repair recommendations for various reaches. The Foott report also included a tabulation of reconnaissance efforts by the California State Department of Water Resources (DWR). The reconnaissance performed by the DWR involved interviews with various reclamation districts to determine past performance and specific problems with the levees. This information was compiled and included as an appendix to the Foott report and are reiterated in this report. In 1990, the Sacramento District, Geotechnical Branch prepared an Office Report on the Mid-Valley Study area (ref. 1). That report made preliminary recommendations for levee repairs at various locations and provided the geotechnical input necessary to complete the Initial Appraisal Report.

C. GEOLOGY AND SEISMICITY

A complete description of the geology and sesimicity is covered an appendix ___ of the General Design Memorandum. In terms of seismic hazard, the project is in seismic zone 3, defined as major risk of damage. However, as with all other phases of the Sacramento River Flood Control System Evaluation, earthquake remediation measures are neither authorized nor considered in evaluating stability of the existing levee system. During nonflood periods, it is likely that damage to levees in the study area during a significant earthquake would be limited. Damage could be significant in the remote possibility of a nearby and significant earthquake occurring at the same time as a flood. This possibility is considered extremely remote. In the event this did occur, damages would likely not include bypass levees, but be confined to the Sacramento or Feather River levees, where loose sand fill and foundation deposits could liquefy and result in scattered slumping of the levee crown.

D. EXPLORATIONS

In May and June 1989, as part of the initial phase of investigation, a total of twenty, 6-inch-diameter auger borings (2F-89-1 through -20) with Standard Penetration Tests (SPTs) and 55 Cone Penetrometer sites (CPTs) (CPT-89-1 through -55) were drilled. Some additional explorations were conducted by the Corps of Engineers in the early 50's and are used to supplement the explorations at the reported problem study sites. Thirty three 6-inch diameter auger borings with continuous standard penetration tests (SPTs) were conducted in 1993 at sites where problems were identified in the Corps 1990 office report (ref. 1, Appendix B). These were borings 2F-93-1 to 2F-93-29. Some borings with an "A" designation (e.g. 2F-93-7A) were drilled at the landside toe of the levee, while all others were drilled through the levee crown. Various other explorations were performed in some locations to investigate site specific problems in past years. The locations of the explorations are shown in profile for the various sites studied.

E. LABORATORY TESTING

Laboratory testing of samples collected during the various study phases of this project was performed by the South Pacific Division Laboratory in Sausalito, California. The bulk of the testing was soil classification. These tests included Atterberg Limits (Liquid Limits and Plastic Limits) and Mechanical Analyses. Lesser amounts of testing, primarily on the fine-grained soils found mostly in the bypasses, included consolidated-undrained shear strength tests and unconfined compression tests. Lime modification testing was also performed during the Colusa Basin Drain and Knights Landing Ridge Cut Study (ref. 3). Results of the laboratory tests are discussed as relevant in the following paragraphs for each study reach. Laboratory test results for the reports,

including the most recent explorations, performed in 1993, are maintained in Geotechnical Branch, Soil Design Section files.

F. SUTTER BYPASS, RIGHT BANK - TISDALE WEIR TO SACRAMENTO RIVER

The right bank levee of the Sutter Bypass (Figure 2) extends approximately 22 miles from Tisdale Bypass to its confluence with the Sacramento River. The levee crest is 20 feet wide and gravel surfaced. The levee is typically from 15 to 25 feet high. An irrigation ditch approximately 50 feet wide and 10 feet deep parallels the landside levee toe. A borrow pit paralleling the levee on the bypass side was created from the original levee construction which was performed by private interests in the 1920's. In 1942, the Corps of Engineers modified the levee by widening the levee crown to its present 20 feet and flattening the side slopes to the current 1V on 3H landside and 1V on 4H on the bypass side.

1. PAST PERFORMANCE

This reach of levee has generally performed well, and there is no record of a total levee failure. However, there has been a history of seepage and piping problems during high water in the bypass. When there is water in the bypass, which can last for up to 3 months, sand boils occur in the adjacent landside irrigation ditch. The most significant of these sand boils occurred in February 1986 when seepage and foundation piping developed at a location immediately north of Maddock Road. Fine sand from beneath the levee piped into and nearly completely filled the nearby irrigation ditch paralleling the levee. This resulting internal erosion of the levee foundation caused a 500-foot section of the levee crown to slump a maximum of about 4 feet. A complete levee failure was averted only by emergency measures undertaken by the Corps of Engineers. Dump trucks dumped rock, sand, and gravel on the waterside slope to create a berm 50 feet wide and 300 feet in length. This action resulted in a significant reduction in the seepage by closing off voids created by the piping. Although complete failure was avoided, the damage was extensive. It was determined from a subsequent exploration program that a nearly continuous layer of silt and fine sand up to 7 feet thick remained beneath an upper clay cap from 7 to 10 feet thick. The levee repair was completed in December 1986 under Corps of Engineers Public Law 84-99 authority. The repair included excavating and replacing the remaining sandy foundation material with imported and compacted finer grained material.

As documented in the reclamation district's inspection logs and office reports since about 1970, sand boils have been a serious problem in many locations along the bypass levee. Sandbags have been stacked in the landside irrigation ditch and adjacent to the levee toe in several locations to control piping during high water. In fact, sand boils have been so common the reclamation district has placed markers, numbered 1 through 20, along the landside shoulder at the boil locations. Reclamation district personnel continue to monitor these sites during high water. Except for the near catastrophic failure in February 1986, the sand boils have been controlled by creating sandbag chimneys around the sand boils to create sufficient head to halt the migration of material from the boil. Two locations, Sites 1 and 2, have been particularly troublesome with a history of boils. The reclamation district has made some attempts in the past to isolate and cut off lenses of sand suspected of causing the problem. Difficulty in isolating the sand deposits and dealing with caving that occurs when deposits of clean sand are encountered made such attempts only minimally successful. Of the 20 documented sand boil locations, 7 are located in Site 2.

Near the southern end of the bypass, about 2 miles north of the Sacramento River, is Site 3.

This is a location where levee landside slope instability has historically been a problem. Landside slope failures occurred in this area in 1980 and 1983. Public Law 84-99 repairs included removing the slide material and blending and recompacting the levee fill and foundation material. No slope failures have been reported in this reach since 1983.

2. EXPLORATIONS AND LABORATORY TESTING

Fifteen explorations were performed at Sites 1 through 3. These include 2F7-8, 2F7-9 and 2F7-11 by the Corps in 1957, 2F-89-2 and -4 and CPT -89-10,-13 through -15 by private consultant, and 2F-93-1 through -6 by the Corps. The 2F explorations are auger borings with Standard Penetration Tests (SPT), and CPT explorations are cone penetrometer tests. Classification testing was performed on several bag samples, and some unconfined compression testing and triaxial shear testing was performed on undisturbed samples collected. The triaxial shear tests were performed for evaluating slope stability at Site 3.

3. SITE DESCRIPTIONS AND RECOMMENDATIONS

3-1. SITES 1 AND 2. (Figure 8)

3-1a. SITE CONDITIONS The levee soils at Sites 1 and 2 consist primarily of soft to very stiff, low plasticity sandy clay (CL) with isolated fill consisting of clayey sand (SC). The levee material was borrowed from the existing landside irrigation ditch and the borrow ditch paralleling the levee on the bypass side. These soils are predominantly basin clays. Although the two borings through the levee at Site 1 did not encounter clean sand deposits (i.e. less than 5% fines) within the foundation, several borings at Site 2 did reveal that clean sand deposits do exist about 10 to 12 feet below the natural ground surface. This sand is a feature of the Pleistocene alluvium which underlies the basin clay. This alluvium is made up of alternating layers of clay, silt, and sand.

3-1b. CONCLUSIONS AND RECOMMENDATIONS. Except for Site 3, as will be described below, where slope instability has been a problem, foundation piping of sand lenses and potential levee failure are of significant concern along the right bank of the bypass where sand boils have occurred. The most notable example of this threat is the well documented near total failure in February 1986, just north of Maddock Road. One of 20 historical boil locations (Boil 3) is located very close to this site. Therefore, in addition to Sites 1 and 2, where sand boils are a regular occurrence during flooding in the bypass, there is a potential for significant levee damage and failure at other sand boil locations. Most of the sand boils occur in the landside irrigation ditch next to the levee. A landside interceptor trench drain is recommended at the other documented boil site locations in addition to Sites 1 and 2. These sites are identified as Sites 2-1 through 2-10. See Table 2. The estimated depth of the trench would be 15 feet, but would extend no deeper than 20 feet depending on the depth to the top of the sand deposit. Similar seepage control measures were made in 1958 on the east bank of the bypass from about 1 mile south of Wadsworth Canal to Gilsizer Slough (40,000 feet) and again in 1970 on the west bank beginning at a point approximately 1.4 miles north of Tisdale Bypass and extending 18,000 feet northward. Sand boils similar to those at Sites 1 and 2 as well as ground heave were a significant problem at both of these locations. Since installation of those trench drains, no problems have been reported.

3-2. SITE 3 (Figure 9)

3-2a. SITE CONDITIONS. At Site 3, the levee and foundation soils to a depth of at least 20 feet below the natural ground surface consist predominantly of high plasticity clay (CH). Three CPT borings in this location intercepted sand at a depth of 20 to 22 feet below the natural ground surface. Plasticity Indices (PI) of samples tested from borings 2F-89-4 and 2F-93-6 at this site range from 34 percent to 42 percent and average 38 percent. Clay soils with a PI greater than 30 in arid to semiarid regions are known to have a high potential for developing shrinkage cracks and swelling upon wetting. The levee in this reach of the bypass is characterized by desiccation cracks on the levee slopes, particularly on the landside, and longitudinal stress cracks typically on the upper portion of the slope and on the levee crown paralleling the levee. The shrinkage cracks typically extend to depths of 3 to 5 feet. Slides are triggered when heavy rainfall in the winter follows the long dry summer. The extensive cracking of the surface material results in an increase in the mass permeability of the embankment. As a consequence, the upper portion of the embankment, particularly along the contact area of the unweathered clay and upper weathered clay becomes saturated. As a consequence, shallow failures develop typically in the upper 5 to 7 feet of the embankment. When the failures develop on the lower portion of the landside slope, there is a tendency for progressive failure toward the levee crown.

3-2b. CONCLUSIONS AND RECOMMENDATIONS. As described above, landside slope instability has been a problem at Site 3. It is recommended that a 1-mile reach, beginning at the Sacramento Slough and extending upstream, be remediated. The levee at this site consists of high plasticity clay, which is as described above, susceptible to seasonal shrinkage and swelling which results in reduced shear strength. Although the failures to date have been relatively shallow and have not yet resulted in total breaching of the levee, it is possible that the progressive sloughing and loss of levee crown elevation could result in a complete breach of the levee during high water in the bypass. Therefore, it is recommended that corrective measures be taken to improve this condition. Slides to date have been on the landside slope of the levee. This may be partially explained by the fact that the slope on the bypass side is flatter at 1V on 4H compared to 1V on 3H on the landside. It is also possible that riprap on the waterside may partially protect the waterside slope from moisture changes. The proposed treatment for this site is to chemically stabilize the clay (CH) material using hydrated lime, $Ca(OH)^2$, stabilization techniques. This technique has been successfully used by the Corps of Engineers in the St. Louis, and Memphis Districts, on similar levee soil conditions (ref. 4). Lime stabilization would involve blending and compacting approximately 4 percent lime into the outer 4 feet of the levee slope. This procedure will reduce the PI of the clay to well below 20 percent. Shrinkage cracks in the outer slope will be virtually eliminated with a significant increase in the shear strength. The lime-treated levee material will act as a cap, preventing large moisture changes in the underlying levee material, and will be resistant to shrinkage and swelling cycles. As a result, the levee will be significantly more stable. Other methods of using lime have been used such as lime injection. But there are some uncertainties in the effectiveness of this technique. The recommended technique is to excavate the outer 4 feet of the levee slope and crown, blending with lime and moisture conditioning, followed by recompaction in approximate 9-inch horizontal loose lifts. Further details of the construction procedures will be developed during final design.

G. SACRAMENTO RIVER, LEFT BANK - TISDALE WEIR TO FREMONT WEIR

This reach of the left bank of the Sacramento River (Figure 2) is maintained by R.D. 1500. The levee is approximately 34 miles in length from Tisdale Weir to the confluence of the Sacramento River and Sutter Bypass. The levees in this reach vary from about 13 to 20 feet in height and crown widths vary from about 15 to 20 feet. The side slopes are variable, but generally are 1V on 2H landside and 1V on 3H on the waterside. The levees are constructed primarily of sand dredged from the Sacramento River or borrowed from nearby deposits of silty sand (SM) or clayey sand (SC). The levee crown is typically gravel surfaced with short reaches asphalt paved. Landside irrigation ditches adjacent to the levee toe exist along portions of this reach.

1. PAST PERFORMANCE

There are no reports of past levee breaches in this reach. Except for past bank protection work, records along this reach of the Sacramento River indicate minimal problems. Information obtained during the 1989 reconnaissance efforts reveal the problems that have occurred have been seepage related. Sand boils have not been reported. To date, most of the reported seepage problems are apparently of the nuisance variety and have typically resulted in saturated conditions of adjacent farmland. However, four sites, Sites 4 through 7, have been identified where seepage has been most significant. Although sand boils have not been reported, seepage through the levee at Sites 4 and 5 has been reported, and landside slippage was reported in the past in the vicinity of Site 7. Cross sections of these sites are shown on Figures 19 through 21.

2. EXPLORATIONS AND LABORATORY TESTING

A total of 15 explorations were performed at these 4 sites. During the 1989 explorations, one auger boring and 4 CPTs were drilled through the levee crown (Figures 10 and 11). Ten additional auger borings with continuous SPTs were drilled in 1993. Available explorations prior to this study included two auger borings (2F-1 and -1A) drilled in 1952 in the area described as Site 7. Laboratory testing on samples collected during these investigations were for soil classification purposes and included gradation and Atterberg Limits testing. These tests were performed to verify field descriptions obtained during drilling and to provide data for evaluating the susceptibility of the levee and foundation materials to seepage and piping.

3. SITE DESCRIPTIONS AND RECOMMENDATIONS

3-1. SITE 4 (Figure 10)

3-1a. SITE CONDITIONS. Generalized seepage, including through-levee seepage, has been reported at Site 4 during high river stages. Explorations in this location generally indicate levee and foundation soils would not be particularly vulnerable to seepage related problems. The explorations indicate these soils typically consist of alternating layers of sandy clay, clayey sand, and clay. However, as indicated in the cross section (Figure 19), there are also scattered layers of clean sand in the levee and the lower foundation. The landside slope is particularly steep at 1V on 1.6H. Given the history of through-levee seepage at this site and the relatively steep landside slope, instability during high river stages is very possible.

3-1b. CONCLUSIONS AND RECOMMENDATIONS. The levee landside slope at this site is very steep. A very low berm, apparently locally constructed, about 3 feet high and only about 5 feet wide abuts the landside toe along a portion of this reach. This berm may have been constructed by local representatives in an attempt to prevent sloughing near the landside toe of the levee. In any case, the berm is inadequate, and a new seepage/stability berm should be constructed along this entire reach. Two or three residential structures exist fairly close to the levee along this reach. Construction around or otherwise dealing with this situation will be evaluated during final design. Localized omission of the berm may be considered. The berm will not prevent nuisance seepage in the farmland beyond the levee toe. It will, however, sufficiently improve levee stability and minimize the potential for sand boils near the landside toe of the levee during high river stages.

3-2. SITE 5 (Figure 10)

3-2a. SITE CONDITIONS. Site 5 has been reported to be an area where seepage occurs beyond the levee toe during flooding. A typical cross section of this site is shown on Figure 20. The levee and foundation in this area consist of relatively fine-grained soils. One boring, CPT-89-4, intercepted clean sand deposits at a depth of about 20 feet beneath the natural ground surface. This could not be verified by the borings drilled in 1993 as they terminated about 10 feet higher than this depth. Since the sand deposit here appears to be relatively deep, there does not appear to be a major concern of shallow foundation seepage that could lead to piping. Seepage emerging in the field could be the result of a combination of cultivation, irrigation ditching, and shallower undetected relatively clean sand deposits.

3-2b. CONCLUSIONS AND RECOMMENDATIONS. The problem at Site 5 is believed to be primarily nuisance seepage during high river stages that could interfere with farming activities. The levee landside slope is a relatively flat 1V on 2.3H. Consequently, levee instability is not a serious concern at this site. However, localized steepening near the landside toe of the levee resulting from the proximity of the adjacent irrigation ditch is of concern. This condition can cause shallow sloughing during high river stages that could lead to more serious problems such as progressive failure of the landside slope. It is recommended that the irrigation ditch in this reach be backfilled, and the levee slope be regraded to a uniform slope in areas that have been steepened near the toe of the levee. Furthermore, it is recommended that irrigation ditches not be constructed any closer than 50 feet from the levee toe. This will not reduce seepage in the interior farmland, but it will improve the overall stability of the levee and minimize the potential for undetected near surface sand lenses in the foundation to potentially cause sand boils in the ditch.

3-3. SITE 6 (Figure 11)

3-3a. SITE CONDITIONS. The levee at Site 6 consists of clean sand with fines content ranging from only 3 to 6 percent. Similar to Site 5, the landside slope at this site is also relatively flat at 1V on 2.5H (Figure 20). Standard penetration blow counts (N) ranged from N=3 to 8 and averaged around 4. N values less than 5 in a sand material indicate very loose density and consequently a fairly low shear strength. Although the landside slope is relatively flat, a slope stability analyses resulted in a minimum factor of safety of 1.2, which is below Corps criteria of

1.4. The foundation materials consist predominantly of finer grained material; i.e. sandy clay (CL), clay (CL), silty sand (SM) or sandy silt (ML) to a depth of approximately 25 feet. Only one boring, CPT-89-3, extended below this depth and encountered clean sand to at least 30 feet, the depth of the boring. Therefore, foundation seepage is not seen as a major concern, but the levee soils are highly pervious and susceptible to seepage-related slope instability during high river stages.

3-3b. CONCLUSIONS AND RECOMMENDATIONS. Slope stability analyses at Site 6 resulted in a minimum factor of safety of 1.2. This is below Corps criteria of 1.4. Significant improvement is realized with a seepage/stability berm approximately one-third the levee height. The analyses with a berm in place resulted in a minimum factor of safety of 1.78. The foundation soils at this site are predominantly fine grained and are not particularly susceptible to seepage and piping. Therefore, in order to assure the levee in this reach meets stability criteria, a seepage/stability berm is recommended.

3-4. SITE 7 (Figure 11)

3-4a. SITE CONDITIONS. The landside slope is relatively flat at 1V on 2.4H (Figure 21). Explorations at Site 7 indicate the levee consists predominantly of very loose to loose sand (SP). Similar to Site 6 these materials are highly pervious and susceptible to seepage. Two other borings, one just downstream of this site, indicate nearby levee soils are comprised of firm to stiff clayey sand (SC). Given the variability of possible borrow sources, including river-dredged material, this variation in levee material is not unusual. The foundation to a depth of about 15 feet consists of fine-grained soils, including soft clayey sand (SC) and soft clay (CL). Loose deposits of clean sand were encountered beneath about 15 feet.

3-4b. CONCLUSIONS AND RECOMMENDATIONS. As indicated earlier, landside slope instability was reported within the limits of Site 7. In addition, the loose and clean sand levee fill makes future stability in this area questionable. A slope stability analysis revealed a minimum factor of safety of 1.15. Reanalysis with a berm approximately one-third the height of the levee improved the factor of safety to 1.63. Therefore, the recommendation at this site is for a seepage/stability berm similar to that proposed for Site 4.

H. SACRAMENTO RIVER, RIGHT BANK - KNIGHTS LANDING TO SACRAMENTO BYPASS

The right bank levee of the Sacramento River in this reach (Figures 3 through 5) begins upstream at Knights Landing and extends downstream about 26 miles to its confluence with the Sacramento Bypass. Five different agencies have the responsibility for maintaining the levees in this reach. Beginning upstream at Knights Landing, the levees to Fremont Weir are maintained by Yolo County, R.D. 1600 maintains the levees to just upstream from Interstate 5, R.D. 827 maintains the levees to County Road 124, and R.D. 785 and R.D. 537 maintain the remaining reach downstream to the Sacramento Bypass. The levees consist predominantly of sandy material dredged from the river or adjacently borrowed finer grained sandy clay or silt. Levee heights typically range from about 13 to 19 feet. Crown widths are variable, ranging from 14 to 40 feet. Most of the levee crown in this reach is gravel-surfaced with about a 2-mile reach upstream from

Fremont Weir an asphalt two-lane paved road. The levee slopes are generally 1V on 2H on the landside. On the waterside the slopes are typically 1V on 3H, but are variable. The design freeboard is 3 feet, but actual freeboard is as much as 7 feet in some areas.

1. PAST PERFORMANCE

Most of the levee problems reported in this reach are generalized seepage. At a few of these locations, through-levee seepage or sand boils near the landside toe have also been reported. There are no records of recent failures in this reach. However, near R.Ms 78.5 and 80.9, two old levee breaks are documented on R.D. 1600 inspection logs. During the February 1986 flood, the levee was damaged at three locations within R.D. 1600. Two of the locations had significant amounts of seepage, including numerous boils near the landside toe (R.Ms. 78.2 and 81.1), and another location (R.M. 78) had significant erosion of the waterside slope. All three sites were repaired in 1986 under the Corps' Public Law 84-99 authority. The eroded site, which was 400 feet in length, was repaired by reshaping the slope, and each of the seepage sites were fortified with a 10-foot-wide, 3-foot-high seepage berm. The lengths of the berms were 170 and 600 feet. During the field investigation of this study, it was noted both berms have been partially or completely obliterated, apparently by farming equipment.

2. EXPLORATIONS AND LABORATORY TESTING

Explorations in this reach include those conducted in 1963 by the Corps of Engineers, a short distance upstream from the Sacramento Bypass. These were 15-foot-deep, 4-inch-diameter hand auger borings (2F-63-1 through -5) drilled at the levee landside toe to evaluate soil conditions for the Sacramento River Bank Protection Project. Two 40-foot-deep, 8-inch-diameter auger borings were drilled in 1986 at the northern portion of R.D. 1600. These explorations (RD1600-5 and -6) were conducted by Wahler Associates (ref. 5) as part of the Public Law 84-99 levee assessment of the need for remediation in locations where seepage and sand boils occurred during the 1986 flood. In 1989, several explorations were conducted to generally characterize the levee and foundation conditions throughout this study reach. These included six CPT borings (CPT-89-19,-20,-44,-45,-51, and -55) and three 6-inch-diameter auger borings (2F-89-8,9, and 10) varying in depth from 42 to 45 feet. In 1993, seven auger borings (2F-93-15 through -21) varying from 35 to 50 feet in depth were drilled to provide additional levee and foundation data primarily at the problem sites.

Laboratory testing of samples collected from the explorations included soil classification testing, including gradation analyses and Atterberg Limits tests. One unconfined compression test was performed on a sample at a depth of 42 feet (30 feet below the foundation) in boring 2F-89-10. The resulting unconfined compression strength of the sandy clay sample was 0.98 tsf which correlates well with the Standard Penetration Test N value of 10 just above and below the sample location.

3. SITE DESCRIPTIONS AND RECOMMENDATIONS

The levees along this reach are comprised mainly of loose, clean sand. However, the explorations indicate some reaches are constructed of either sandy clay (CL) or sandy silt (ML). Apparently, depending on the method and time of construction of the various reaches, material was either borrowed from the adjacent land near the levee (clay or silt) or sand (SP) dredged from the river bottom. Except for a few isolated locations, the levee sand is very loose to loose (N=2

to 10). The foundation soils to a depth of about 20 to 25 feet are predominantly fine grained, ranging from clay (CL) and clayey sand (SC) to silty sand (SM) and silt (ML). Sand and gravel deposits are encountered at a depth of about 25 feet below the ground surface upstream from about R.M. 79. For example, at boring 2F-93-15 (Figure 12), a sample collected at a depth of about 32 feet below the surface was classified as a poorly graded sand with silt and gravel (3/4" maximum size). Downstream from about R.M. 78, the foundation and levee soils are predominantly fine grained to at least a depth of 35 feet below the ground surface.

3-1. SITE 8 (Figure 12)

3-1a. SITE CONDITIONS. This is a reach of levee approximately 1000 feet long that has been identified where seepage develops and ponds in the adjacent farmland. The levee section at this site (Figure 21) was measured at 18.5 feet in height with a waterside slope of approximately 1V on 6H and a landside slope of 1V on 2.2H. The crown width measures 21 feet. Explorations at this site indicate the levee material consists of relatively low permeability firm to stiff sandy clay (CL) or sandy silt (ML). One exploration, 2F-93-15, drilled just upstream of this site, revealed the levee material upstream is probably more susceptible to seepage than is Site 8. The upper approximately 20 feet of the foundation is also relatively impermeable, consisting of soft to firm material similar in composition to the levee in this reach. However, below a depth of about 20 feet to at least 35 feet, the depth of the explorations, the foundation consists of a firm to dense stratum of a sand with silt (SP-SM) with up to 10 percent gravel to 3/4 inches in diameter.

3-1b. CONCLUSIONS AND RECOMMENDATIONS. It is concluded that the seepage ponding in the farmland in this area is not a result of through-levee seepage or even near-surface foundation seepage. The levee cross section is at least as flat as the standard 1V on 3H waterside and 1V on 2H landside with a 20-foot crown width. It is believed that seepage in the farmland is the result of deep underseepage that through imperfections or localized pervious lenses in the foundation or irrigation ditches is finding a way to the surface. The levee itself is believed to be stable. There are no recommendations to reduce the seepage that is reported at this site.

3-2. SITE 9 (Figure 12)

3-2a. SITE CONDITIONS. According to reclamation district personnel, this is a location where clear seepage emerged from the lower levee slope and toe during the 1986 flood. The levee crown (Figure 22) at the narrowest portion of this short reach is 24 feet wide, but is significantly wider at the downstream end. The levee height was measured at 11.5 feet, and both waterside and landside slopes are about 1V on 3H. There is a waterside pond surrounded by lush vegetation, including large trees, immediately adjacent to this site. Although not known for certain, the pond is likely the result of a past levee break or old river meander. A 35-foot-deep exploration, 2F-93-17, indicates the levee material consists of clean sand (SP). One sample tested had only a 5 percent fines content. The foundation materials to at least 25 feet consist of firm to stiff deposits of clay (CL) or sandy clay (CL).

3-2b. CONCLUSIONS AND RECOMMENDATIONS. The levee at this site consists of clean loose sand, which is susceptible to seepage. The levee landside slope is a relatively flat 1V on 2.8H. Therefore, instability would not be anticipated. Given the reports of seepage at this

location, through-levee seepage and foundation piping is a concern. To minimize the potential for more serious problems at this site, it would be prudent to control any future seepage with a landside seepage/stability berm and toe drain. As an alternative, a 20-foot-deep slurry cutoff wall through the levee crown could be constructed. If the cutoff alternative were used, it should be longer in order to minimize seepage that could originate upstream or downstream of the site. A cutoff wall, if selected should be on the order of 300 feet longer than the berm alternative. The foundation soils are predominantly fine grained and a slurry wall could key into finer grained foundation soils and provide an effective cutoff.

3-3. SITE 10 (Figure 12)

3-3a. SITE CONDITIONS. This location was identified as an area where at least one sand boil required sandbagging during the 1986 flood. The levee section at this site (Figure 22) is only 7.5 feet high, and the waterside and landside slopes are relatively flat. Two borings, CPT-89-20 and 2F-89-8, were performed at this site. The borings indicate the levee materials range from clean sand to silty sand. The foundation at this site consists of firm clay (CL) and sandy clay (CL) or silt (ML) deposits to a depth of 25 feet below the foundation contact where a stratum of loose clean sand extending to at least 35 feet below the foundation is encountered.

3-3b. CONCLUSIONS AND RECOMMENDATIONS. The 1986 flood elevation was about 1.5 feet higher than the design flood level at this location. With the favorable levee geometry and relatively low head during flooding at this site, it would seem unlikely that significant through-levee or upper foundation seepage would develop. However, boils have been reported here. Undetected sand lenses in the foundation have apparently caused the seepage and related boil conditions. Although the 1986 flood was slightly higher than the design flood, to be conservative, it is recommended that measures be taken to minimize any potential for a future flood to threaten this site. A landside seepage/stability berm and toe drain is recommended. Similar to Site 9, a cutoff wall 20 feet deep from the top of the levee could be considered as an alternative. Again, selection of a cutoff wall would include some lengthening of the site by an estimated 300 feet overall.

3-4. SITE 11 (Figure 12)

3-4a. SITE CONDITIONS. This reach has been reported as having had seepage emerge from the levee landside toe and into the field during flooding. The levee at this site (Figure 23) has a crown approximately 31 feet wide and a 1V on 2.5H waterside slope and a very steep 1V on 1.4H landside slope. The explorations at this site show significant portions of the levee section to consist of very loose to loose sand (SP). Similar to other sites evaluated in terms of slope stability, the levee geometry at this site and the pervious, loose nature of the levee fill make the levee susceptible to slope instability during high river stages. The foundation soils are predominantly fine grained consisting of clay (CL) and sandy clay (CL) or clayey sand (SC) to at least 20 feet below the ground surface, the depth of the explorations.

3-4b. CONCLUSIONS AND RECOMMENDATIONS. It is recommended that a landside seepage stability berm be constructed at this site. The berm will control through-levee seepage, thereby significantly improving overall levee stability. The seepage/stability berm will not prevent seepage out into the field, but in addition to improving stability, it will minimize the

potential for sand boils in the vicinity of the levee toe which can lead to piping and internal erosion of the levee foundation.

3-5. SITE 12 (Figure 12)

3-5a. SITE CONDITIONS. Site 12 is the closure section of the old Sacramento River channel just upstream from the Fremont Weir. The closure section is only about 100 feet wide. The levee side slopes (Figure 23) are extremely overgrown with large oak trees and other vegetation. A 12-foot-wide aging asphalt surface exists on the 26-foot wide levee crown. The levee landside height is about 18 feet and the waterside height is about 11 feet. The side slopes are 1V on 1.9H landside and 1V on 4.2H riverside. Standing water fills the existing old river channel and abundant riparian wildlife exists around the old channel. According to the landowner, a siphon through the closure provides irrigation water to the old river channel. The 1986 flood elevation at this location was about 1 foot higher than the design flood level. However, visual inspection of the site reveals that at least the material on the outer portions of the levee is relatively fine grained, consisting of either a sandy silt or sandy clay soil. During the 1986 flood, a small sand boil was reported near the landside toe. County personnel successfully controlled the boil by sandbagging.

3-5b. CONCLUSIONS AND RECOMMENDATIONS. This site successfully passed the design flood. Although during higher flood levels, a sand boil could reoccur, this location is very isolated. Seepage problems could easily be controlled if necessary by sandbagging. Therefore, it is recommended that no remedial repairs be made to this site. The landside slope at this location is extremely overgrown. It would be prudent for the responsible maintaining agency to clear some of vegetation at this site so that inspections and potential flood fighting are not hindered by the excessive vegetation. This location should be monitored for new signs of seepage or sand boils during future floods.

3-6. SITE 13 (Figure 12)

3-6a. SITE CONDITIONS. The levee in this reach (Figure 24) is about 16 feet high with a 1V on 2H landside slope. Little or no berm exists on the densely vegetated and consequently difficult to inspect riverside slope. The approximately 36-foot-wide levee crown is gravel surfaced. Farming operations have also caused localized steepening of the lower portion of the landside slope of the levee. Explorations at this site show the levee and upper 3 to 5 feet of the foundation consists mainly of clean, very loose to loose fine sand (SP). Except for the upper few feet of foundation sand, the foundation consists of firm sandy clay (CL) or silty sand (SM). Seepage at the toe of the levee was reported at the site during the 1986 flood. In fact, following a Public Law 84-99 study for the Corps, a geotechnical consultant (ref. 5) made a recommendation to install a 3-foot-high, 10-foot-wide, 600-foot-long gravel seepage berm to minimize any potential for future sand boils. The berm was subsequently installed, but has since apparently been obliterated by farming equipment.

3-6b. CONCLUSIONS AND RECOMMENDATIONS. Based on past performance and site conditions, this site is believed to be vulnerable to either slope instability or underseepage and piping failure. It is also noted that an apparent old levee break, referred to as the Caffaro Break in R.D. 1600's inspection log, occurred near the downstream end of this site. It is recommended

that a landside seepage/stability berm be constructed at this site. The seepage berm will improve overall slope stability and minimize the potential for seepage-induced piping near the levee toe during future high river stages. Since this reach includes damaged Public Law 84-99 work done in 1986, it is not necessary to replace the berm prior to constructing the new seepage/stability berm.

3-7. SITES 14 AND 14-1 (Figure 12)

3-7a. SITE CONDITIONS. Site 14 levee materials consist of poorly graded sand (SF) with only 4 percent fines in two samples tested. The foundation soils are predominantly fine grained and classified as silt (ML) or silt with sand (ML). The levee (Figure 24) is approximately 11 feet high, and the crown is about 41 feet wide and the side slopes are relatively steep at 1V on 1.7H. The shoulders and outer slopes of the levee appear to have been recently widened by the reclamation district by dumping and shaping relatively clean fill material on the side slopes. This material is loose, and the side slopes are standing at about the angle of repose or natural angle when the material was dumped. The loose nature of the material on the slopes has resulted in some surficial downward migration of the sandy material by erosional runoff and either animal or human traffic. Consequently the slopes are relatively uneven throughout this reach. Site 14-1 is described below.

3-7b. CONCLUSIONS AND RECOMMENDATIONS. Site 14 was originally identified in the IAR as being susceptible to seepage. However, within Site 14, Public Law 84-99 repairs have been made to remediate a seepage condition there in 1986. The repair was a gravel seepage berm, 3 feet high, 10 feet wide, and 170 feet long. The problem at that site was considered to be remediated with the installation of the berm. However, during the field inspection, it was observed that the berm had been partially obliterated by the excavation of an irrigation ditch located very close to the levee toe. The only recommendation for this site is that the 170-foot toe berm be reconstructed as originally installed by the Corps. Other than this repair, no other corrective action is considered necessary. Localized sloughing of the additional loose levee fill may occur, but will likely be minimal and not progress into the original levee section. The side slopes should be maintained by the local reclamation district. There are no recommendations proposed for this reach. Immediately upstream of this site, however, is a short levee reach (Site 14-1) that is potentially vulnerable to landside instability. This site (Figure 25) was noted during a field visit to Site 14. The levee material at this site consists of clean loose sand. The side slopes are steep and vary from about 1V on 1.4H to 1V on 1.7H (approximate natural slope in loose state). Visible signs of downslope movement of loose sand are visible, and very little vegetation exists or is able to establish itself on the steep and loose dry slope. Farm equipment and machinery have been stockpiled on the levee slope and can present an access problem should flood fight efforts be required at this location. The existing steep landside slope shows signs of deteriorating. It is recommended that the landside slope be flattened to at least to 1V to 2H either by cutting into the existing levee or by adding fill to the existing landside slope. The flatter slope will provide stability during flooding and will also be more conducive to the establishment of natural grasses and other vegetation that will help reduce erosion.

3-8. SITES 15 TO 17 (Figure 13)

3-8a. <u>SITE CONDITIONS.</u> Explorations between Sites 15 and 17 indicate the levee materials consist predominantly of very loose to loose sandy silt (ML) or silty sand (SM). The foundation soils are predominantly fine grained and classify as soft to stiff clay (CL) or loose to firm silty sand (SM). Cross sections for Sites 15 (Figure 25) and 17 (Figure 26) show a significant variation in levee geometry throughout this reach. The landside slope at Site 17 is relatively steep at 1V on 1.6H. However, except for the disturbance of the slope material due to squirrels, the levee slope shows no sign of being in a loose or unstable state such as noted at Site 14-1. In general, the levees are 10 to 15 feet high, crown widths range from 20 to 35 feet, and side slopes are relatively flat on the waterside at about 1V on 4H. But as seen at Site 17, the landside slopes are steeper in some areas. A slightly elevated two-lane paved county Road 117 parallels the landside toe throughout this reach.

3-8b. <u>CONCLUSIONS AND RECOMMENDATIONS</u>. Sites 15 through 17 were originally identified in the Initial Appraisal Report as areas that were more susceptible to seepage than other portions of the levee downstream from about R.M. 77 and therefore in need of remediation. In this followup study, there appears to be no indication that these sites are any more prone to seepage than any other location downstream from about R.M. 77. Furthermore, the levees in this area performed well during the 1986 flood, which is estimated to be about 2 feet higher than the design flood. Seepage in the agricultural land protected by the right bank levee of the Sacramento River in this reach, is believed to be influenced primarily by deep underseepage and not considered a significant threat to levee stability. Therefore, there are no recommendations for remediation of the previously identified Sites 15 through 17.

I. YOLO BYPASS - LEFT BANK LEVEE (R.D. 785 and R.D. 827)

This portion of the left bank levee of the Yolo Bypass (Figure 5) extends from the upstream end at River Road, which is just north of the I-5 crossing to the north bank levee of the Sacramento Bypass. R.D. 827 maintains the upstream 2.8 miles and R.D. 785 maintains the downstream 3.1 miles. The two reclamation districts are separated by County Road 124.

1. PAST PERFORMANCE

This reach of levee has been plagued with landside slope failures (sloughing). The failures (see Figures 14 and 15) have generally been only 75 to 150 feet wide and have occurred following periods of heavy rainfall and flooding in the Yolo Bypass. Major slides typically start out as small slides at the landside toe or quite often at the edge of the nearby irrigation ditch. Characteristically, the slide progresses up the levee slope and deeper into the levee section, sometimes involving the levee crest. The slides also tend to be somewhat self stabilizing. After significant movement has taken place, the lower portion of the slide mass tends to serve as a stabilizing berm. In recent years, plastic sheeting has been placed on the failed slope by emergency flood fighting crews to minimize saturation and possible enlargement of the slide. Following past flood events, the Corps of Engineers has routinely repaired the slides under Public Law 84-99 authority by removing the slide material to below the slide plane and reconstructing the damaged portion of the levee using the same levee material as excavated. In some instances,

the adjacent landside ditch has been relocated as part of the repair. Recent failures in R.D. 827 include three in 1983 and three in 1986. Four slope failures occurred in R.D. 785 in 1983.

2. EXPLORATIONS AND LABORATORY TESTING

In 1956, two 8-inch-diameter, 30-foot deep auger borings were drilled from the levee crown in R.D. 827. Several explorations were conducted under A/E contract at locations of slides that occurred during the 1986 flood. These included 8-inch-diameter, 30-foot-deep auger borings (RD827-1, 2, 3 and RD785-1 ,2, and 4). One 40-foot-deep cone penetrometer boring, CPT-89-52, and a 6-inch-diameter, 40-foot auger boring 2F-89-16 were drilled during the initial phase of investigation of this study. During the final investigation phase, two 40-foot-deep borings, 2F-93-22 and -23, were drilled along a portion of the R.D. 827 levee where landside slope instability has been particularly troublesome. All the described explorations were drilled through the levee crown. Laboratory testing included primarily soils classification testing and triaxial shear strength testing of samples collected in borings 2F-93-22 and -23.

3. SITE DESCRIPTION AND RECOMMENDATIONS

3-1. SITE 18 (Figures 14 and 15)

3-1a. SITE DESCRIPTION. The levee in this reach (Figure 26) varies from approximately 15 to 20 feet high, and the crown width is generally about 20 feet. The side slopes are for the most part about 1V on 2.5H, with some slopes slightly flatter at about 1V on 3H near the upstream third of this reach. The crown is gravel surfaced throughout. Surface shrinkage cracks are a predominant feature of this entire reach. The landside slope in most of the reach is very irregular, apparently a result of past surface slides. The levee material consists mainly of firm to stiff fat clay (CH), which is defined as clay soils with a Liquid Limit (LL) greater than 50. The levee material in this reach consists of only between 2 and 24 percent sand content. Atterberg Limits tests show the LL of the levee soils range from 44 to 69 (avg. 59) and the Plasticity Index (PI) ranges from 27 to 47 (avg. 36). It is commonly known that clay soils with a PI of between 15 and 30 have a moderate potential for cracking (volume change), and clay soils with a PI greater than 30 have a high potential for cracking. The foundation soils are similar except that some of the foundation soils classify as low plasticity clay (CL) with Liquid Limits slightly less than 50, and some portions of the upper foundation contain deposits of organic clay and some decaying vegetable matter. In the summer, the levee soils are characterized by numerous cracks on the crown and side slopes. Shrinkage cracking of levee soil during the dry summer months and swelling during the wet winter months, create a continual cycle of wetting and drying which results in a weathering and weakening effect of the outer levee material. The shear strength of the upper approximately 5 to 7 feet of the levee is significantly reduced. During the winter, rain saturates this outer material and causes softening and loss of apparent cohesion. The reduced (residual) strength (ϕ = 23 degrees) in combination with the heavier saturated levee slope and added effect of water filling the cracks induces shallow sliding. As described earlier, the slides typically start at a location where there is little lateral support (adjacent irrigation ditch) and progress upward and deeper into the levee section.

3-1b. CONCLUSIONS AND RECOMMENDATIONS. The entire 5.9-mile reach of the left bank Yolo Bypass levee (R.D. 827 and R.D. 785) consists predominantly of high plasticity clay (CH). This material is subject to weathering cycles which results in a decreased shear strength.

As described above, the residual shear strength of the levee soils have made this reach vulnerable to sloughing during periods of heavy rain. Where adjacent ditches have been involved, the sloughs have been relatively deep. Historically. this has been a significant problem near the southern half of R.D. 827 where the irrigation ditch was adjacent to the levee toe. After 1986, a little over a mile of the ditch was relocated to between 75 and 100 feet from the levee toe. The ditch relocation has resulted in an overall improvement. However, future sloughing of the levee slope will continue to be a problem even in this reach. If this reach is not remediated, slope failures will continue to be a problem. It is recommended that the entire reach be remediated. The recommended method involves soil modification by mixing the existing landside slope and upper few feet of the levee material with lime and recompacting. This method will be similar to that described for Site 3 on page 5. If the remediation is unjustified economically, at a minimum, the landside irrigation ditch should be relocated wherever it is closer than 35 feet from the levee landside toe. The area where this condition exists is roughly the northern 1-mile reach of R.D. 827, where the ditch is immediately adjacent or very close to the levee toe. The actual dimensions of this reach will need to be field verified prior to final design.

J. FEATHER RIVER/SACRAMENTO RIVER - LEFT BANK BEAR RIVER TO THE NATOMAS CROSS CANAL

The levee in this reach is approximately 14 miles long (Figure 6). It extends from the confluence of the Feather River with the Bear River at the upstream end to about 1 mile downstream from its confluence with the Sacramento River. The levee is maintained by R.D. 1001. The upstream 3 miles are set back from the main river channel 1000 to 4000 feet. The next 11 miles are adjacent to the river with a natural berm typically 10 to 30 feet wide. The levee height varies from approximately 15 to 25 feet. Paved Garden Highway exists on the levee crown downstream from the town of Nicolaus. The crown is from 25 to 35 feet wide, and the side slopes, although variable, are typically 1V on 2H landside and 1V on 3H riverside. The design freeboard is 3 feet for that portion of the levee upstream from the confluence of Sutter Bypass and 5 feet downstream of the confluence with the Sutter Bypass.

1. PAST PERFORMANCE

The prevailing problem along this levee reach is seepage in the field beyond the levee toe. During high river stages, the interior farmland becomes saturated and increased flow develops in irrigation and drainage ditches. High river flows in 1955 resulted in a levee break on December 23, about 1 mile downstream from Nicolaus. An intentional cut, "the Verona cut," was made at the lower end of the Feather River in early 1956 to drain the floodwaters created by the Nicolaus break. Both breaks were subsequently repaired by the Corps of Engineers. A number of historical breaks that may have occurred in the 1800's have resulted in randomly infilled channels of pervious sand. An obvious break location is near R.M. 2.3 (Site 20). At this location a pond exists in the scour hole adjacent to the levee. Five locations (Sites 19 through 23) were identified in the IAR as having particularly notable seepage problems. These locations are discussed further below.

2. EXPLORATIONS AND LABORATORY TESTING

Two explorations (Figure 16) were performed along this reach of levee prior to 1993. The

pre-1993 explorations included one auger boring, 2F-89-19, and one cone penetrometer boring, CPT-89-49. In 1993, explorations conducted at the identified problem sites included 2F-93-24, 25, 26, 26A, 27, and 27A. As with other exploration samples collected along the major river system, primary testing was performed including gradation and Atterberg Limits tests.

3. SITE DESCRIPTIONS AND RECOMMENDATIONS

The levees along this reach consist primarily of sand dredged from the Feather River and are therefore potentially susceptible to seepage. Based on samples tested during the exploration program, the levee soils vary between very loose to loose clean sand to loose silty sand. Fines content varies from only 4 to 11 percent. Standard penetration blow count (N) for the levee material ranges typically between 3 and 6. This is indicative of sand material with a relatively low shear strength of less than $\phi = 30°$. Not only do these materials have a relatively low shear strength, but they are also susceptible to through-levee seepage and consequent slope failure. Slope failure is a particular concern, particularly where the sandy slopes are steeper than about 1V on 2H. The foundation soils are typically finer grained and classify from sandy silt (ML) to clay (CL). However, based on reports of seepage landward the levee for much of this reach, there are likely deeper and scattered old sandy channels within the foundation in some areas.

3-1. SITE 19 (Figure 16).

3-1a. SITE CONDITIONS. This site was originally identified as a site where an artesian boil was reported during high flow in the Sacramento River. Further discussions with R.D. 1001 personnel revealed that this condition is of little concern. This is actually a site where a pump is used to provide irrigation water in the summer months. During high river stages, typically in the winter months while the pump is not operating, there is some flow out of the pump well. This flow is always clean and has never presented any problems. No explorations were performed at this site.

3-1b. CONCLUSIONS AND RECOMMENDATIONS. After further review of this site, no remediation is considered necessary. A pump at this site serves essentially as a relief well by relieving foundation pressure and flowing clear water during high river stages.

3-2. SITE 20 (Figure 16)

3-2a. SITE CONDITIONS. Site 20 is the location of an apparently undocumented levee break (Figure 27). The resulting landside scour hole is now a stagnant pond. The pond is lush with vegetation and surrounded by large trees. According to a district representative, the pond becomes deeper during high river stages. The length of this site is approximately 400 feet. Exploration 2F-93-24 through the levee crown indicates the levee, which is a maximum of 24 feet high near the center of the site, consists of clean loose sand (SPT N values consistently ≈ 3) for the entire levee section. The foundation consists of similar material with slightly higher N values ranging from 5 to 14, representing loose to firm density. Both the levee and foundation soils are highly permeable and therefore subject to levee and foundation saturation during high river stages.

3-2b. CONCLUSIONS AND RECOMMENDATIONS. Of particular concern at this site is the high and relatively steep landside slope. Slope stability analysis at this site results in a minimum factor of safety during the design flood stage of 0.75 (Figure 27). Recent floods may

not have been of sufficient duration to cause complete saturation of the levee section and consequent slope failure. Foundation piping potential was also evaluated. For the existing condition the factor of safety against piping was calculated to be 2.3 (Figure 28). Although not particularly low, the factor of safety against piping as determined using a flow net analysis should be at least 4.0. With the potential threat to slope stability and possible foundation piping, the traditional recommendation would be a landside seepage/stability berm. However, given the potentially significant environmental impact at this site, an alternative repair might be considered. A possible solution would be waterside seepage control, which could be accomplished using a slurry wall to partially cut off seepage. A clay blanket or an impermeable buried geomembrane would also be incorporated on the waterside slope to eliminate through-levee seepage. A flow net analysis was performed to determine the underseepage piping potential with a 25-foot-deep cutoff wall constructed from the waterside berm (Figure 29). With the 25-foot-deep cutoff, the factor of safety against piping improves to 4.2. The results of the flownet analyses are very sensitive to adjustment and interpretation in the shape of the flownet. Nevertheless, the analysis does provide a good approximation of the factor of safety as well as the relative change in factor of safety using a cutoff wall compared to the existing condition. The cutoff wall in combination with the waterside blanket will provide adequate stability from slope failure and possible foundation piping. If waterside control measures are selected, the length should be increased to account for end-around seepage. An increased distance of 200 feet on either side, for a total of 800 feet, is recommended.

3-3. SITE 21 (Figure 16)

3-3a. SITE CONDITIONS. This site is also about 400-feet in length and may also be the location of a historical levee break. There is a shallow depression adjacent to the levee toe about 300 feet long, which is overgrown by dense vegetation. The levee at this site is approximately 25 feet high with a waterside and landside slope of 1V on 4H and 1V on 2H respectively (Figure 27). According to a local reclamation district representative, although no known sand boils or slope failures are known to have occurred in this location in the past, seepage emerges near the landside toe during high river stages. Also, it was noted during the field reconnaissance of this site that the toe area was damp, apparently from river seepage. Exploration 2F-93-25 indicates the upper portion of the levee consists of a very loose to loose (N=2 to 6) silty sand and the lower half consists of a very loose to loose clean sand. The foundation to the 30-foot-depth explored consists of soft to firm (N=4 to 8) sandy clay.

3-3b. CONCLUSIONS AND RECOMMENDATIONS. In order to provide greater assurance against a piping or slope failure, it is recommended that a seepage/stability berm be constructed over approximately a 400-foot reach at this location. Because of the possible conflict with landside vegetation at this site, an alternative to the berm would require waterside seepage control measures. This would be similar to the recommendation for Site 20, where a partial cutoff and impervious blanket on the levee slope would minimize the potential for seepage induced instability or foundation piping. In fact, at Site 21, boring 2F-93-25 suggests virtual seepage cutoff could be attained at a relatively shallow depth of about 12 feet beneath the waterside berm. However, to account for possible undetected sand layers, it is recommended that if the waterside control option is used, a cutoff wall depth of 25 feet be used. As with Site 20, if the waterside control measure is selected, an increase in the length to 800 feet should be used to account for possible

end-around seepage.

3-4. SITE 22 (Figure 16)

3-4a. SITE CONDITIONS. The levee at this location is 22 feet high, with 1V on 2.5H landside and 1V on 3H waterside slopes and the crown width is 40 feet (Figure 30). As mentioned above, this is the location of the Verona cut. This intentional levee cut was made in January 1956, about one-third mile upstream from the confluence of the Feather and Sacramento Rivers for the purpose of draining flood water from the December 1955 Nicolaus levee break. Closure of the cut was completed in February 1956. No explorations were conducted in this reach. However, since the source of material used to close the break was obtained from the adjacent Feather River, it is believed the levee consists of relatively clean sand. According to R.D. 1001 records, the cut was approximately 800 feet wide. An old aerial photograph owned by R.D. 1001 may provide an indication of the approximate location of the cut. According to a representative of R.D. 1001, a gravel or rock core used to armor the base and sides of the cut was left in place prior to closure of the section. This may partially explain why this reach is reported to seep part way up on the landside slope during high river stages. To date however, there have been no reports of slope failure or internal erosional of the levee material.

3-4b. CONCLUSIONS AND RECOMMENDATIONS. A gravel or rock blanket placed as a weir may have been left in place prior to closure of the 1956 Verona cut. Since the landside slope is relatively flat at 1V on 2.5H, slope stability is not a major concern. However, with a continuous blanket of rock through the levee, this reach is vulnerable to through levee seepage and possible internal erosion. Obtaining records of the precise area of the "cut" has been difficult. Therefore, although a seepage\stability berm is recommended for this reach, the limits of the repair are tentative. According to preliminary information, it is estimated that the maximum length of the berm would be about 1000 feet.

3-5. SITE 23 (Figure 16)

3-5a. SITE CONDITIONS. Site 23 is a approximately 3000 feet in length and is located between the Natomas Cross Canal and Verona. The levee at this location is approximately 17 feet high as measured from the landside, the crest width is approximately 30 feet, and the side slopes are approximately 1V on 2H on both sides (Figure 31). Two exploration borings through the levee crown in this reach (2F-93-26 and 27) indicate the levee consists of very loose to loose (N=2 to 6) relatively clean sand. The foundation to the explored depth of about 23 feet consists of finer grained, soft to firm (N=3 to 8) sandy clay (CL) to sandy silt (ML) deposits. Boring 2F-93-27A, drilled at the landside toe suggests portions of the upper few feet of the foundation may also contain some clean sand deposits. A companion boring 2F-93-27, drilled from the levee crown, further suggests there may be portions of the foundation where continuous sand deposits exist between the riverside and landside foundation.

3-5b. CONCLUSIONS AND RECOMMENDATIONS. The clean and loose sand material in the levee, the relatively steep landside slope, and the apparent continuity of sand layers beneath the levee indicates the levee in this reach is susceptible to failure by instability or foundation piping during high river stages. Although to date no flood fight efforts have been necessary in this reach, seepage and small sand boils have occurred throughout this reach during high flows

in the Sacramento River. Stability analyses at this site reveal that, during high river stages, instability of the lower portion of the landside slope could develop. The minimum factor of safety determined during the stability analyses was 1.06. This is below the 1.4 Corps criteria. It is recommended that a landside seepage/stability berm with an interceptor trench be constructed in this 3000-foot reach. The berm will significantly decrease any potential for sand boils near the levee landside toe while significantly improving overall slope stability.

K. KNIGHTS LANDING RIDGE CUT - EAST LEVEE

The Corps of Engineers performed an evaluation of the Knights Landing Ridge Cut (KLRC) levees (Figure 7) in 1991 (ref. 3) following the initial phase of study completed by Roger Foott Associates in 1989 (ref.2). Much of the following information on the KLRC levees and conditions are duplicated from the Corps 1991 report. The KLRC was constructed at the turn of the century by local interests to convey irrigation water to nearby fields and to provide drainage during the flood season. The KLRC levees extend for approximately 6.4 miles from the Colusa Basin Drain southeasterly to the Yolo Bypass. Since the levees were reshaped to meet the dimensional standards of the Corps of Engineers flood control project, there have been numerous slide repairs performed by the local reclamation district and the Corps under Public Law 84-99 authority. To date, however, there are no known cases of complete levee failure.

1. PAST PERFORMANCE.

Records dating to 1951 have described levee deformation, slippage, and partial collapse. Levee damage has resulted from a combination of four conditions: (1) loss of strength and cracking of the near surface weathered fat clay (CH) soils (similar to Yolo Bypass east levee), (2) precipitation and possible through levee seepage creating water forces within the levee, (3) a weak layer of foundation organic clay, and (4) oversteepened levee geometry. Many of the failures have been on the landside slope and are often shallow, involving the upper approximately 5 feet of the levee. Deeper slides, sometimes resulting in significant slumping of the crown have also occurred. Similar to slides that occur on the left bank of the Yolo Bypass, the slides along KLRC tend to come to equilibrium after the slide mass forms a crude buttress at the toe of the slide, sometimes "pinching off" the adjacent irrigation ditch. However, before this occurs, typically a 4 to 7-foot vertical escarpment will develop in the crown which can be anywhere from 200 to 1000 feet in length. Past repairs have included removal and recompaction of the failed material to flatter slopes with the inclusion of a stabilizing berm to counterbalance the tendency for rotational failures of the levee fill. A total of 67 levee repair and reconstruction sites have been noted in Corps' documents since 1956.

2. EXPLORATIONS AND LABORATORY TESTING.

Explorations along the east levee of the KLRC (Figure 17) include three Corps 1951 borings drilled to bring the system up to design standards (2F-51-2,4,6). In 1989, borings (CPT-89-37 through -39, and 2F-89-11) were drilled during the initial phase of investigation (ref. 2). An extensive exploration program was undertaken in 1990 for the Colusa Basin Drain and Knights Landing Ridge Cut levee study (ref. 3). These included six levee crown and six landside toe borings (2F-90-7 through -12). These borings were drilled using a 6-inch-diameter hollow-stem auger with SPTs with undisturbed sampling at various locations. The toe borings were drilled to

a depth of 20 feet, and the levee crown boring was drilled to 40 feet. Laboratory testing consisted of soil classification testing, dry density, specific gravity, organic testing, unconfined compression tests, and triaxial shear tests. Design shear strengths selected from the laboratory results included a $\phi = 23.5$ degrees for the embankment and $\phi = 18$ degrees for a clay seam with organics near the foundation contact. Since a significant contributing factor in past slope failures has been desiccation cracking of near surface high plasticity clay, a laboratory testing program was developed to evaluate the suitability of using lime as a soil stabilizing agent. It was concluded that a reduction in the Plasticity Index of these CH soils by about 50 percent can be achieved when lime is mixed with the native clay soil at a ratio of about 4 percent.

3. SITE DESCRIPTION AND RECOMMENDATION.

3-1 SITE 24 (Figure 17)

3-1a SITE CONDITIONS The KLRC consists of two parallel channels excavated using a clamshell dredge. The dredged material was deposited in piles along the levee alignment without grubbing or removal of the surficial organic matter. Several of the borings and excavations of failed reaches have revealed layers of organic material. The levee heights (Figure 32) are typically around 15 feet, the crown width is approximately 20 feet, and the side slopes are variable and range from 1V on 1.5H to 4.0H on the waterside and 1V on 2H to 5.5H on the landside. A landside irrigation ditch, 10 feet deep and 30 feet wide at the top, parallels most of the levee. The ditch is as close as 10 feet and as far as 60 feet from the levee toe. The levee and foundation materials are classified predominantly as fat clay (CH) and lean clay (CL) with occurrences of organics identified in most of the explorations. Most of the reach is characterized by numerous random cracks on the slopes, and in some areas longitudinal cracks are prevalent along the levee shoulder extending 5 to 7 feet beneath the surface. Most of the levee slopes are extremely irregular, and the material has the appearance of being merely dumped by dragline or clam bucket from either adjacent ditches or the KLRC. Some irregularity of the slopes may also be attributed to past shallow slide movement. The levee crown elevation is also uneven in some locations, but freeboard ranging from 3 to 9 feet, is apparently adequate. Organic material encountered near the foundation contact consists of undecayed and partially decayed tule reeds, carbon chunks, and roots. Pockets and seams of sand are encountered at a depth of about 15 to 20 feet below the ground surface.

3-1b. CONCLUSIONS AND RECOMMENDATIONS. A stability analyses was performed at the section described above, near channel mile 4.0 (sta. 317+80, ref. 3). The analyses as shown on Figure 32 indicates the factor of safety for the existing levee condition is 1.02. It was concluded from the 1991 Corps study (ref. 3) that the stability of the levee can be satisfactorily improved by relocating the adjacent irrigation ditch and constructing a berm such that the height of the levee above the berm is no more than about 15 feet. The resulting factor of safety against deep failures with this design is at least 1.63. However, as shown on Figure 32, even with the berm, the minimum factor of safety against shallow slides involving the weathered surficial fat clay is only 1.12. Therefore, while the stabilizing berm can help prevent major slides, continual shallow sloughing will require a significant ongoing maintenance effort. Stability was reevaluated using a flatter landside slope of 1V on 3H. The resulting minimum factor of safety was 1.54. The factor of safety against shallow slides, using the infinite slope method with the 1V on 3H slope, is only 1.27. This is still less than the criteria of 1.4. Since the fat clay (CH) material will

always be subject to seasonal weathering cycles (shrinkage and expansion), it will always have a low residual shear strength (est. ϕ = 23 degrees). It is recommended that similar to Site 3, the surface material to a depth of 4 feet be improved with lime stabilization. In addition to improving the shear strength of the outer slope material, the lime treatment will create a capping effect that will make the upper levee material resistant to seasonal cracking and weathering and prevent water infiltration into the underlying and possibly fissured levee material. Therefore, in order to meet Corps stability criteria and significantly reduce maintenance on the levee, it is recommended that landside slopes, in what appears to be the most susceptible reach, be flattened to 1V on 3H and the outer material of the levee landside slope be improved using lime stabilization. It is further recommended that the irrigation ditch be relocated to a minimum of 35 feet away from the new levee toe. The recommended improvements to the landside portion of the levee will significantly improve the levee performance in this reach. Although the waterside slope could also be treated with lime stabilization, there are environmental concerns about working in the wetlands area. Therefore, occassional waterside slope failures may develop. As long as these failures are repaired prior to high water in the bypass, the threat of flooding will be minimized. During high water, waterside slope failures are unlikely due to the hydrostatic counterbalancing effect of the floodwater.

TABLE 1
MID-VALLEY RECOMMENDED REPAIRS

SITE NO.	MAINT. AGENCY	BASIS OF DESIGN RECOMMENDATION	APPROXIMATE LOCATION
1	R.D. 1500	Seepage interceptor trench drain	Sutter Bypass C.M. 73.8 - 74.5
2	R.D. 1500	Seepage interceptor trench drain	Sutter Bypass C.M. 70.0 - 71.0
2-1 to 2-10	R.D. 1500	Seepage interceptor trench drains (See Table 2)	See Table 2
3	R.D. 1500	Lime stabilize landside slope and crest	Sutter Bypass C.M. 58.0 - 59.0
4	R.D. 1500	Seepage/stability berm	Sac. River R.M. 116.2 - 117.2
5	R.D. 1500	Fill irrigation ditch and reshape levee toe as necessary	Sac. River R.M. 109.9 - 110.5
6	R.D. 1500	Seepage/stability berm	Sac. River R.M. 104.8 - 105.7
7	R.D. 1500	Seepage/stability berm	Sac. River R.M. 85.2 - 85.9
8	Yolo Co.	None	-
9	Yolo Co.	Install seepage/stability berm w/toe drain - 700 feet	Sac. River R.M. 87.1 - 87.3
10	Yolo Co.	Install seepage/stability berm w/toe drain - 500 feet	Sac. River R.M. 86.8 - 86.9
11	Yolo Co.	Install seepage/stability berm - 2000 feet	Sac. River R.M. 85.2 - 85.6
12	Yolo Co.	None	-
13	R.D. 1600	Install seepage/stability berm - 3700 feet	Sac. River R.M. 80.8 - 81.5
14	R.D. 1600	Reconstruct PL84-99 damaged seepage berm - 170 feet	Sac. River R.M. 78.2
14-1	R.D. 1600	Modify levee landside slope to 1V on 2H - 1800 feet.	Sac. River R.M. 78.4 - 78.75
15	R.D. 1600	None	-
16	R.D. 1600	None	-
17	R.D. 1600	None	-

TABLE 1 (cont.)
MID-VALLEY RECOMMENDED REPAIRS

SITE NO.	MAINT. AGENCY	BASIS OF DESIGN RECOMMENDATION	APPROXIMATE LOCATION
18	R.D. 827 & R.D. 785	Relocate irrigation ditch in northern 1 mile reach of R.D. 827 and lime stabilize outer l/s slope and crest - 6.0 miles	Yolo Bypass C.M. 44.1 - 50.3
19	R.D. 1001	None	-
20	R.D. 1001	Install landside seepage/stability berm - 400 ft. or slurry cutoff wall and waterside blanket - 800 ft.	Feather River R.M. 2.2 - 2.4
21	R.D. 1001	Install landside seepage/stability berm - 400 ft. or slurry cutoff wall and waterside blanket - 800 ft.	Feather River R.M. 0.78 - 0.93
22	R.D. 1001	Install landside seepage/stability berm - 1000 ft.	Feather River R.M. 0.35 - 0.55
23	R.D. 1001	Install landside seepage/stability berm w/toe drain - 2800 feet	Sac. River R.M. 79.0 - 79.5
24	Sacramento River Westside Levee Dist.	Reconstruct l/s slope to 1V:3H & lime stabilize - 3.5 miles Relocate l/s irrigation ditch to 50' from new levee toe	KLRC C.M. 1.4 - 4.9

TABLE 2
ADDITIONAL DRAINAGE TRENCH REPAIR SITES

Site Number	Boil Number	Approx. Levee Mile	Length (Feet)	**Site Number**	Boil Number	Approx. Levee Mile	Length (Feet)
2-1	1	4.22	250	2-6	7-8	10.32-10.38	400
2-2	2	4.89	250	2-7	9	12.09	250
2-3	3	7.67	250	2-8	17	15.45	250
2-4	4	9.13	250	2-9	19	16.12	250
2-5	5-6	9.53-9.60	400	2-10	20	17.14	250

L. REFERENCES

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2. Roger Foott Associates, December 21, 1989. "Geotechnical Assessment of Levees in the Mid-Valley Area, Sacramento River Flood Control System Evaluation."

3. U.S. Army Corps of Engineers, May 1991. "Geotechnical Assessment and Remedial Levee Design for the Sacramento River Flood Control Project, Colusa Basin Drain and Knights Landing Ridge Cut Levees."

4. U.S. Army Corps of Engineers, Waterways Experiment Station, July 1994 (Draft). "Proceedings of REMR Workshop on Levee Rehabilitation."

5. Wahler Associates, Delivery Order No. 0005, July 24, 1986. "Investigation for Levee Repair, RD-1600, Right Bank Sacramento River and RD-827 and RD-785 East Levee, Yolo Bypass, Yolo County, California."

FIGURES

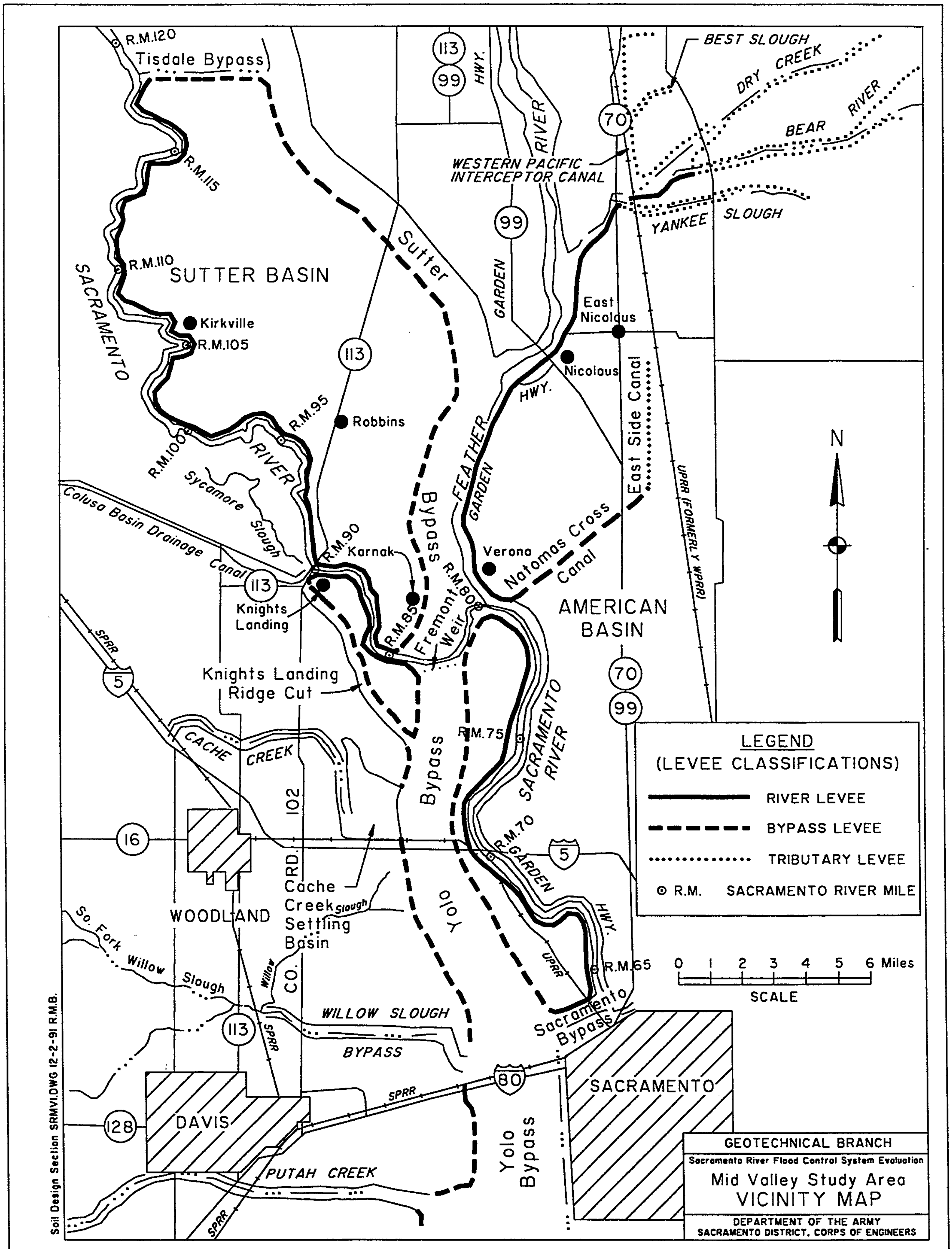

R.M.120
Tisdale Bypass
R.M.115
R.M.110
SUTTER BASIN
SACRAMENTO
Kirkville
R.M.105
R.M.100
R.M.95
RIVER
Robbins
Sycamore Slough
Colusa Basin Drainage Canal
R.M.90
Karnak
Knights Landing
R.M.85
Fremont Weir
R.M.80
Knights Landing Ridge Cut
Sutter Bypass
FEATHER
GARDEN
HWY.
Verona
Natomas Cross Canal
East Side Canal
East Nicolaus
Nicolaus
AMERICAN BASIN
UPRR (FORMERLY WPRR)
BEST SLOUGH
DRY CREEK
BEAR RIVER
WESTERN PACIFIC INTERCEPTOR CANAL
YANKEE SLOUGH
RIVER
N
SPRR
CACHE CREEK
CO. RD. 102
Yolo Bypass
R.M.75
SACRAMENTO RIVER
R.M.70
GARDEN HWY.
UPRR
R.M.65
Cache Creek Slough Settling Basin
WOODLAND
So. Fork Willow Slough
Willow
WILLOW SLOUGH BYPASS
Sacramento Bypass
SACRAMENTO
DAVIS
PUTAH CREEK
LEGEND
(LEVEE CLASSIFICATIONS)
RIVER LEVEE
BYPASS LEVEE
TRIBUTARY LEVEE
R.M. SACRAMENTO RIVER MILE
0 1 2 3 4 5 6 Miles
SCALE
113
99
HWY.
70
16
5
128
80
Soil Design Section SRMVI.DWG 12-2-91 R.M.B.
GEOTECHNICAL BRANCH
Sacramento River Flood Control System Evaluation
Mid Valley Study Area
VICINITY MAP
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 1

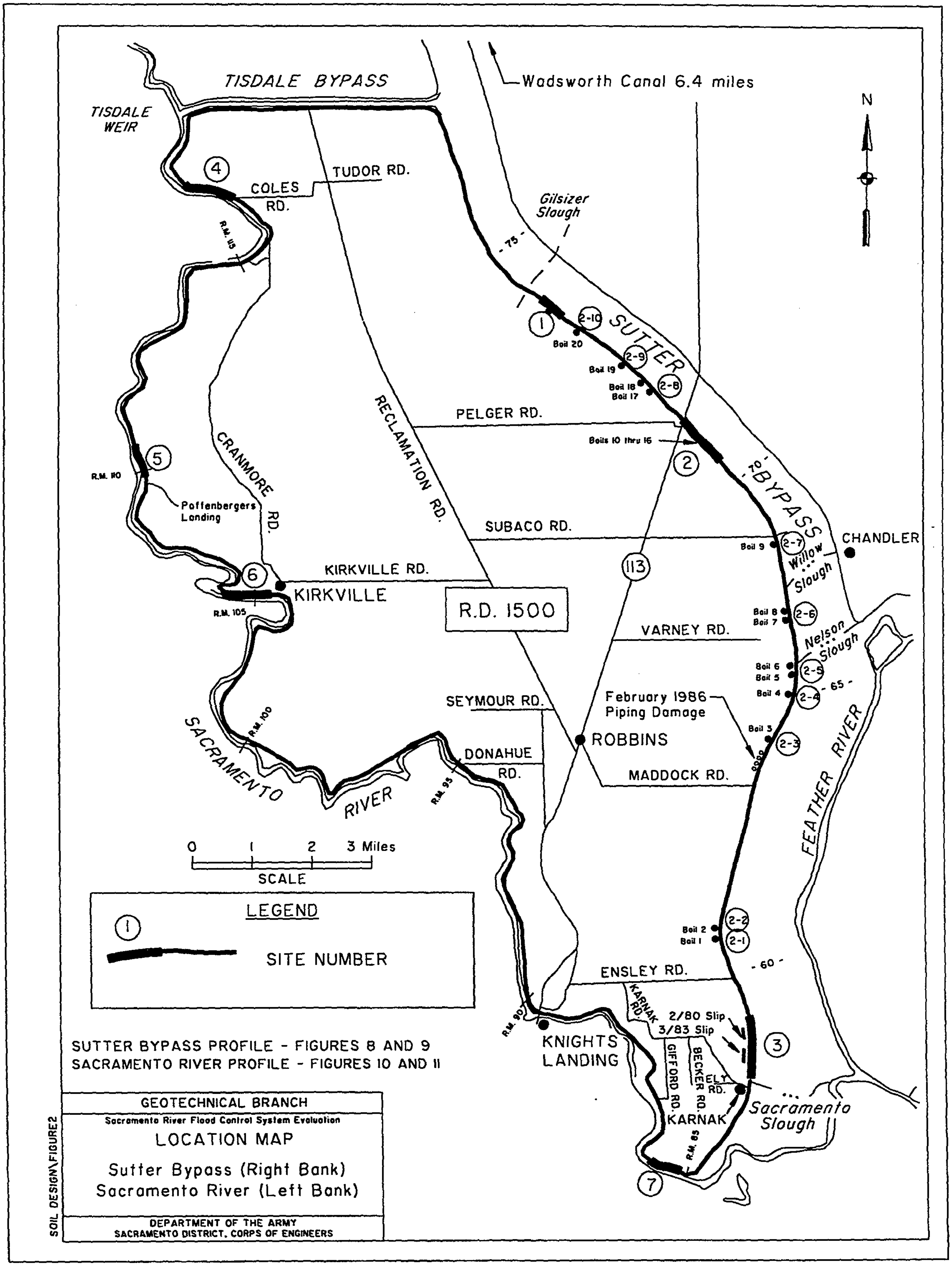
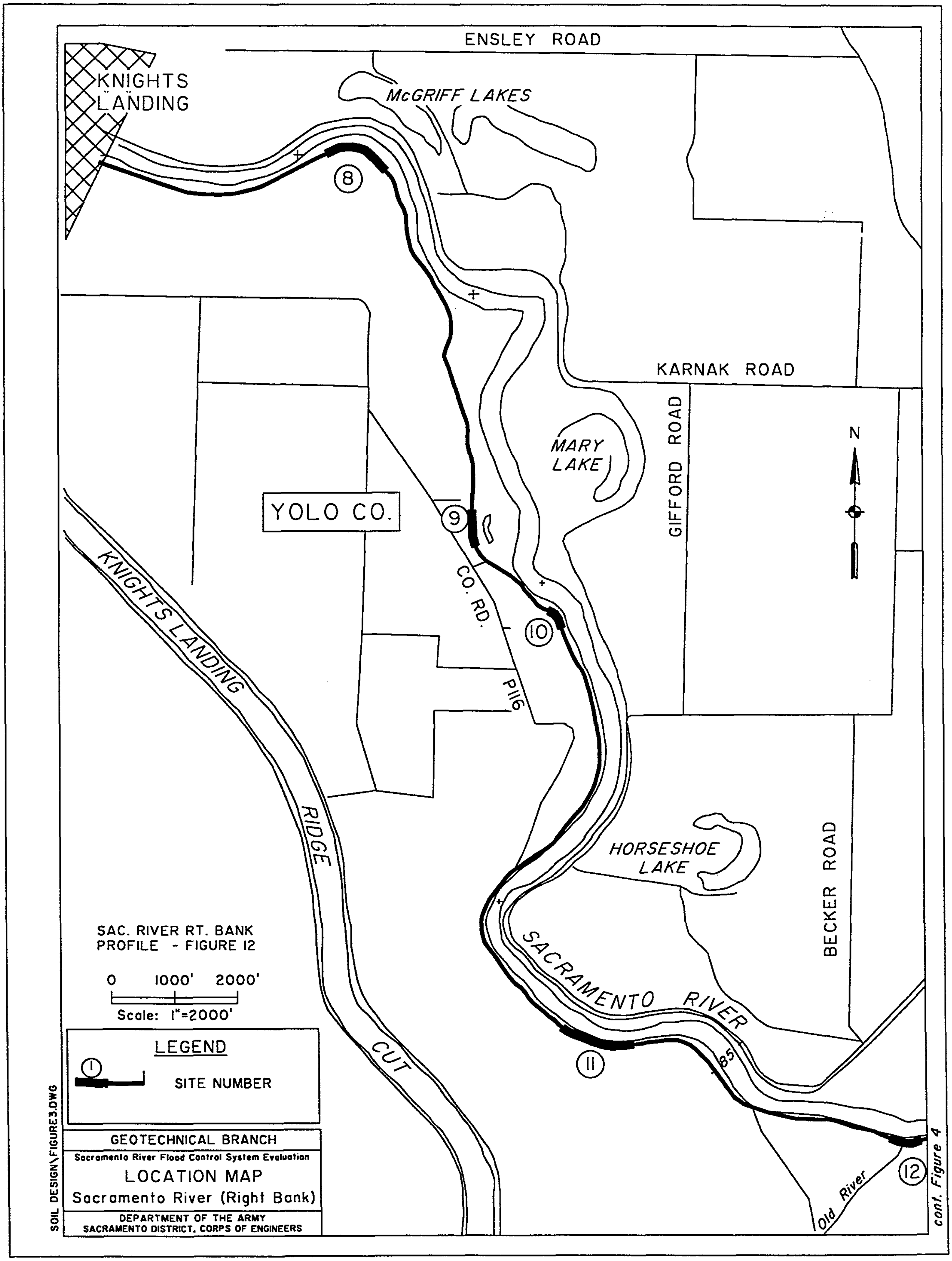

TISDALE BYPASS
TISDALE WEIR
Wadsworth Canal 6.4 miles
N
TUDOR RD.
COLES RD.
Gilsizer Slough
SUTTER BYPASS
Boil 20
Boil 19
Boil 18
Boil 17
PELGER RD.
Boils 10 thru 16
RECLAMATION RD.
CRANMORE RD.
Poffenbergers Landing
SUBACO RD.
CHANDLER
Boil 9
Willow Slough
113
KIRKVILLE RD.
KIRKVILLE
R.D. 1500
Boil 8
Boil 7
VARNEY RD.
Nelson Slough
Boil 6
Boil 5
Boil 4
SEYMOUR RD.
February 1986 Piping Damage
Boil 3
ROBBINS
SACRAMENTO RIVER
DONAHUE RD.
MADDOCK RD.
FEATHER RIVER
0 1 2 3 Miles
SCALE
LEGEND
SITE NUMBER
Boil 2
Boil 1
ENSLEY RD.
KARNAK RD.
2/80 Slip
3/83 Slip
KNIGHTS LANDING
GIFFORD RD.
BECKER RD.
ELY RD.
KARNAK
Sacramento Slough
SUTTER BYPASS PROFILE - FIGURES 8 AND 9
SACRAMENTO RIVER PROFILE - FIGURES 10 AND 11
GEOTECHNICAL BRANCH
Sacramento River Flood Control System Evaluation
LOCATION MAP
Sutter Bypass (Right Bank)
Sacramento River (Left Bank)
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SOIL DESIGN\FIGURE2

FIGURE 2



ENSLEY ROAD
KNIGHTS LANDING
McGRIFF LAKES
8
KARNAK ROAD
MARY LAKE
GIFFORD ROAD
N
YOLO CO.
9
CO. RD.
10
P116
KNIGHTS LANDING RIDGE CUT
HORSESHOE LAKE
BECKER ROAD
SACRAMENTO RIVER
85
11
12
Old River
cont. Figure 4
SAC. RIVER RT. BANK
PROFILE - FIGURE 12
0 1000' 2000'
Scale: 1"=2000'
LEGEND
1
SITE NUMBER
GEOTECHNICAL BRANCH
Sacramento River Flood Control System Evaluation
LOCATION MAP
Sacramento River (Right Bank)
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SOIL DESIGN\FIGURE3.DWG

FIGURE 3

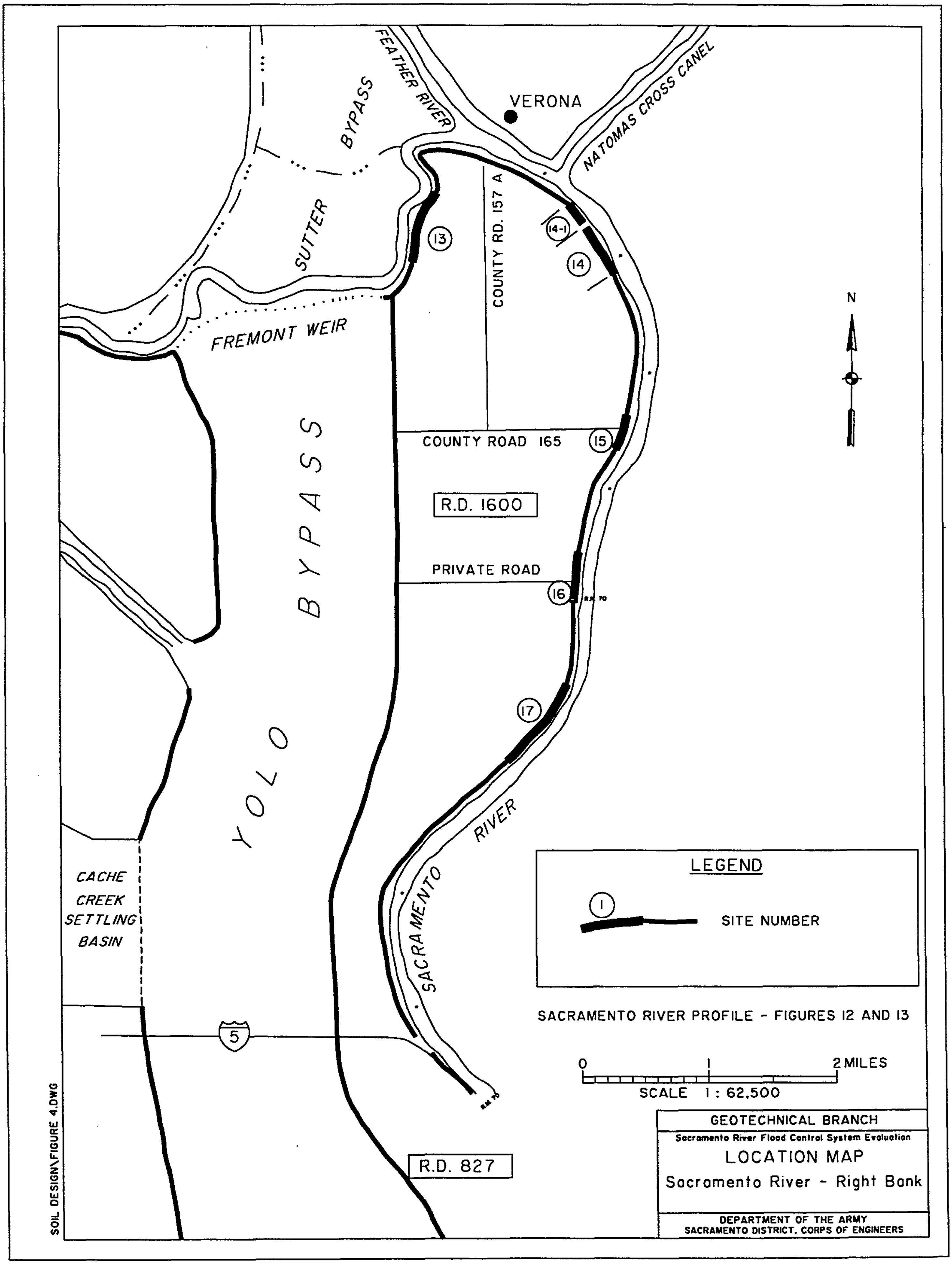

VERONA
FEATHER RIVER
SUTTER BYPASS
NATOMAS CROSS CANEL
COUNTY RD. 157 A
FREMONT WEIR
YOLO BYPASS
COUNTY ROAD 165
R.D. 1600
PRIVATE ROAD
SACRAMENTO RIVER
CACHE CREEK SETTLING BASIN
5
R.D. 827
13
14-1
14
15
16
17
N
LEGEND
1
SITE NUMBER
SACRAMENTO RIVER PROFILE - FIGURES 12 AND 13
0
1
2 MILES
SCALE 1 : 62,500
GEOTECHNICAL BRANCH
Sacramento River Flood Control System Evaluation
LOCATION MAP
Sacramento River - Right Bank
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SOIL DESIGN\FIGURE 4.DWG

FIGURE 4

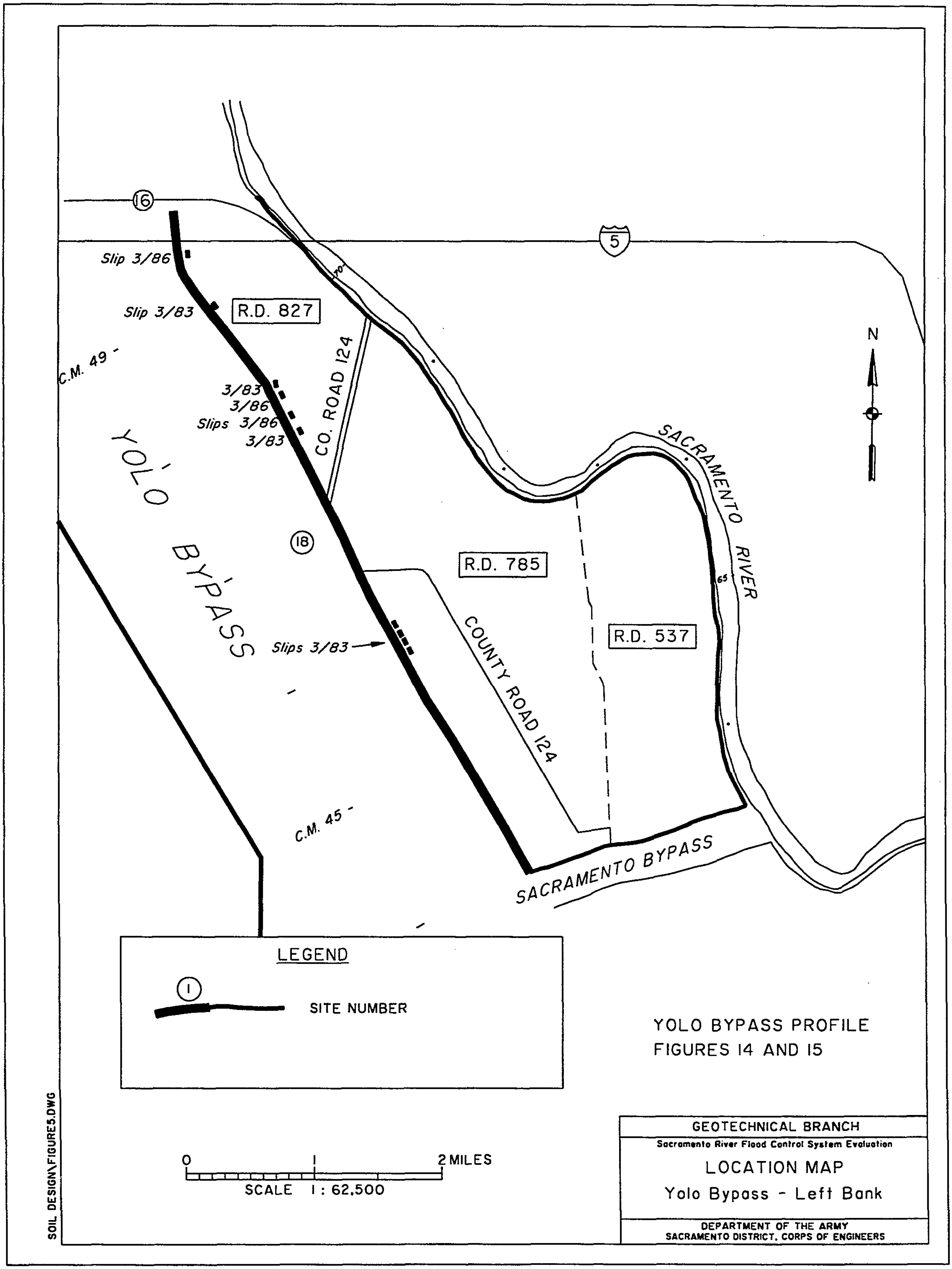

16
5
Slip 3/86
Slip 3/83
R.D. 827
C.M. 49
3/83
3/86
Slips 3/86
3/83
CO. ROAD 124
YOLO BYPASS
18
R.D. 785
SACRAMENTO RIVER
70
65
N
R.D. 537
Slips 3/83
COUNTY ROAD 124
C.M. 45
SACRAMENTO BYPASS
LEGEND
1
SITE NUMBER
YOLO BYPASS PROFILE
FIGURES 14 AND 15
GEOTECHNICAL BRANCH
Sacramento River Flood Control System Evaluation
LOCATION MAP
Yolo Bypass - Left Bank
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
0
1
2 MILES
SCALE 1 : 62,500
SOIL DESIGN\FIGURE5.DWG

FIGURE 5

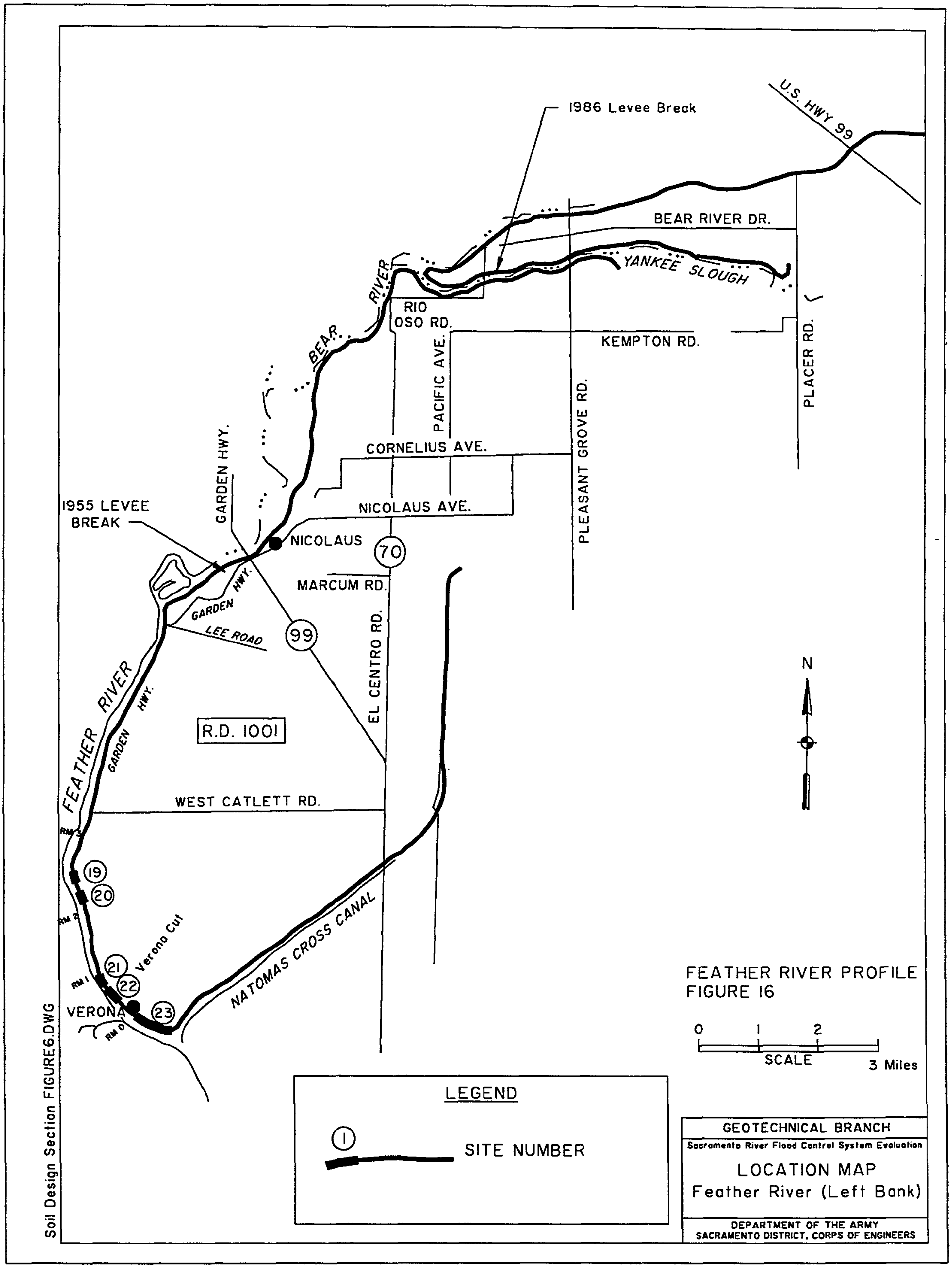

1986 Levee Break
U.S. HWY 99
BEAR RIVER DR.
YANKEE SLOUGH
BEAR RIVER
RIO OSO RD.
KEMPTON RD.
PACIFIC AVE.
PLACER RD.
PLEASANT GROVE RD.
GARDEN HWY.
CORNELIUS AVE.
NICOLAUS AVE.
1955 LEVEE BREAK
NICOLAUS
70
MARCUM RD.
GARDEN HWY.
LEE ROAD
99
EL CENTRO RD.
FEATHER RIVER
GARDEN HWY.
R.D. 1001
WEST CATLETT RD.
RM 3
19
20
RM 2
Verona Cut
21
22
RM 1
VERONA
23
RM 0
NATOMAS CROSS CANAL
N
FEATHER RIVER PROFILE
FIGURE 16
0
1
2
SCALE
3 Miles
LEGEND
1
SITE NUMBER
GEOTECHNICAL BRANCH
Sacramento River Flood Control System Evaluation
LOCATION MAP
Feather River (Left Bank)
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
Soil Design Section FIGURE6.DWG

FIGURE 6

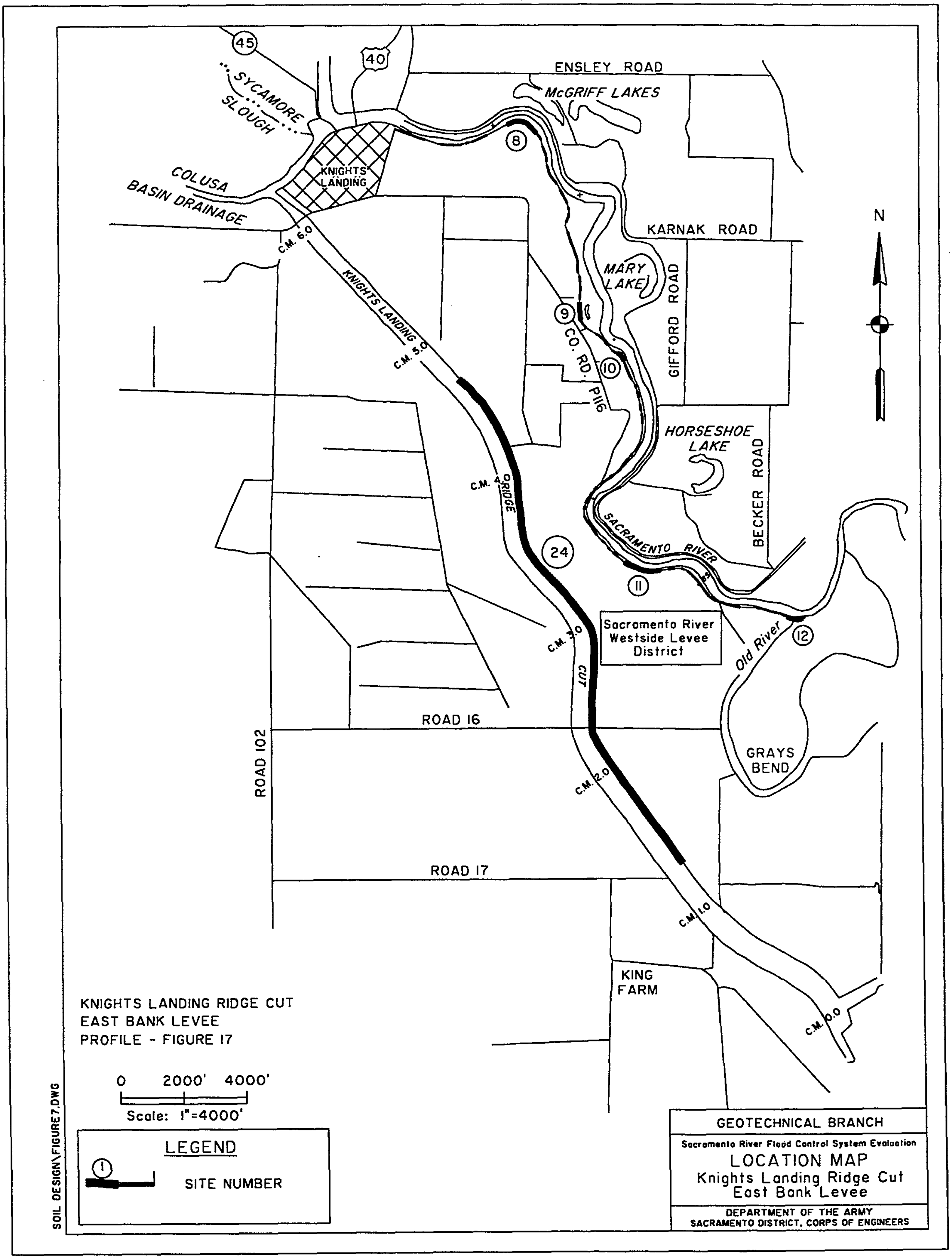
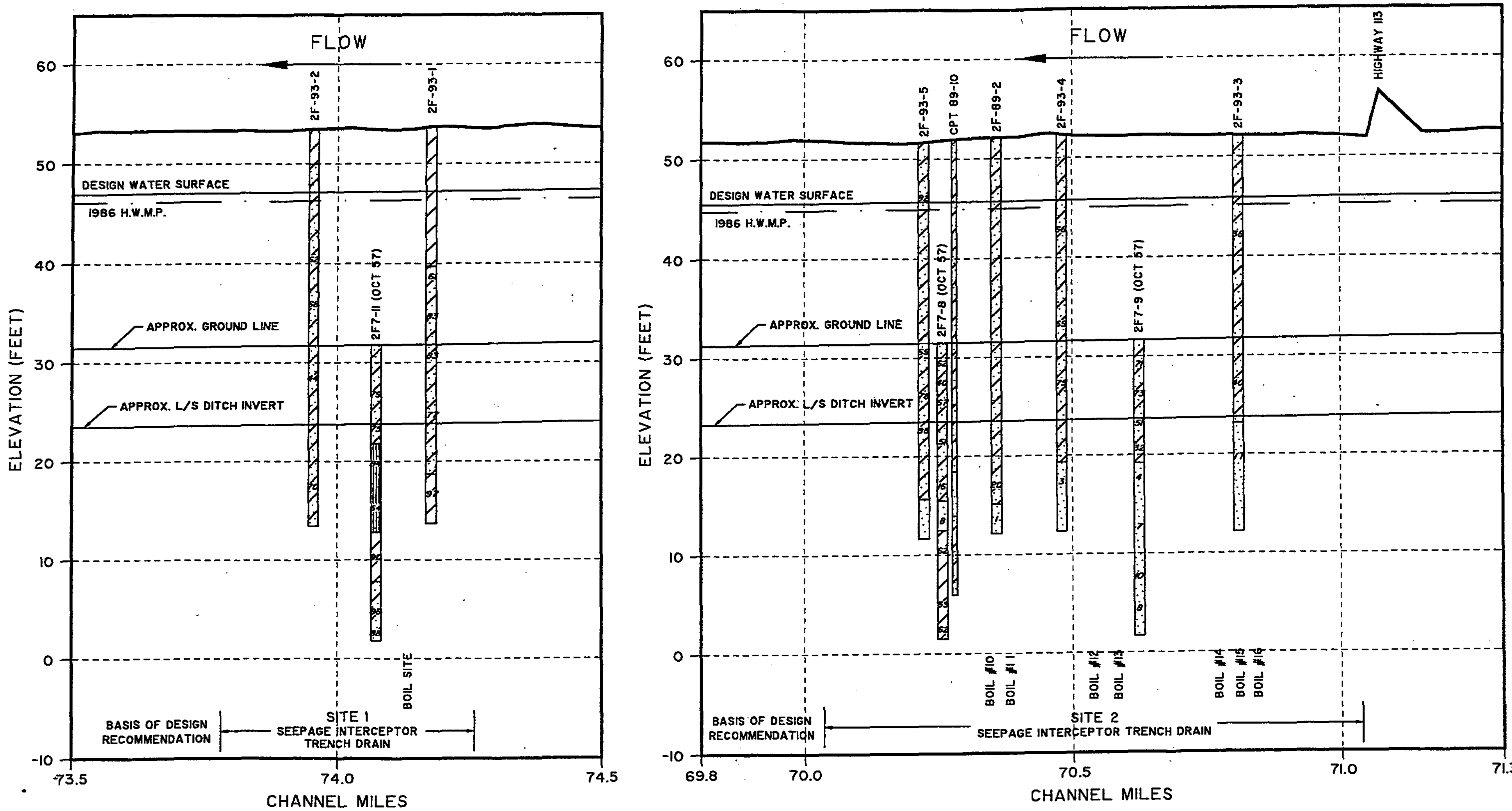

45
40
ENSLEY ROAD
McGRIFF LAKES
SYCAMORE SLOUGH
COLUSA BASIN DRAINAGE
KNIGHTS LANDING
8
KARNAK ROAD
MARY LAKE
GIFFORD ROAD
9
CO. RD. P116
10
HORSESHOE LAKE
BECKER ROAD
KNIGHTS LANDING RIDGE CUT
C.M. 6.0
C.M. 5.0
C.M. 4.0
C.M. 3.0
C.M. 2.0
C.M. 1.0
C.M. 0.0
24
SACRAMENTO RIVER
11
12
Sacramento River Westside Levee District
Old River
GRAYS BEND
ROAD 16
ROAD 17
ROAD 102
KING FARM
N
KNIGHTS LANDING RIDGE CUT
EAST BANK LEVEE
PROFILE - FIGURE 17
0 2000' 4000'
Scale: 1"=4000'
LEGEND
1
SITE NUMBER
SOIL DESIGN\FIGURE7.DWG
GEOTECHNICAL BRANCH
Sacramento River Flood Control System Evaluation
LOCATION MAP
Knights Landing Ridge Cut
East Bank Levee
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 7



LEGEND:

SILT

SILTY SAND OR SANDY SILT (12% - 70% FINES)

CLAY (>70% FINES)

CLAYEY SAND OR SANDY CLAY (12 - 70% FINES)

SAND

GRAVEL

FAT CLAY (LL ≥ 50%)

ORGANICS

PERCENTAGE OF FINES (-200 SIEVE SIZE) PER LABORATORY TESTING

H.W.M.P. HIGH WATER MARK PROFILE

DWS DESIGN WATER SURFACE

RIVER GAGE

SCALES:

VERTICAL SCALE: 1" = 10'
HORIZONTAL SCALE: 1" = 1000'

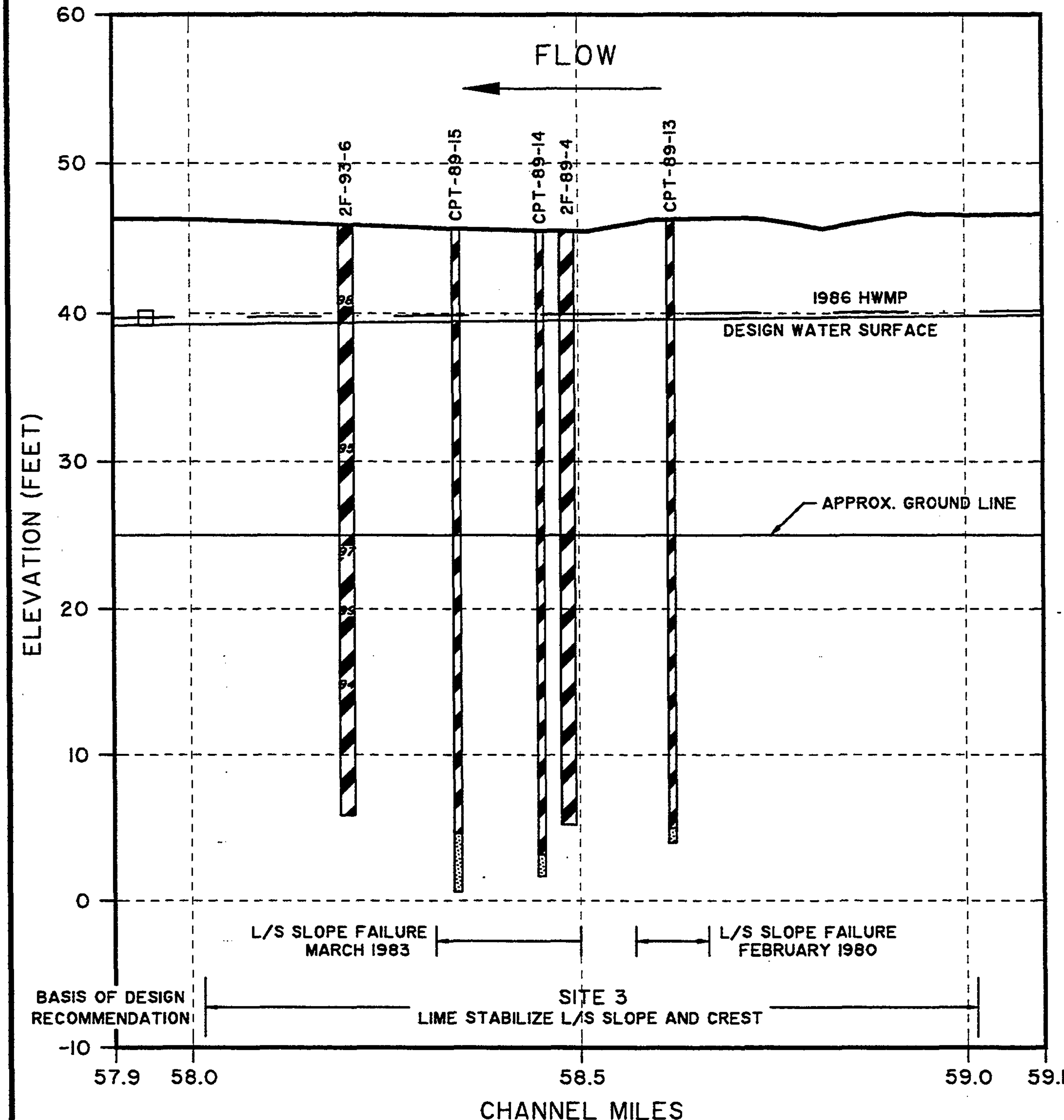
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE PROFILES - R.D. 1500
SUTTER BYPASS
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 8

GEO TECH - SOILS\INASA\MIDV-F08.DWG\10-14-94



SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE PROFILES - R.D. 1500
SUTTER BYPASS
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

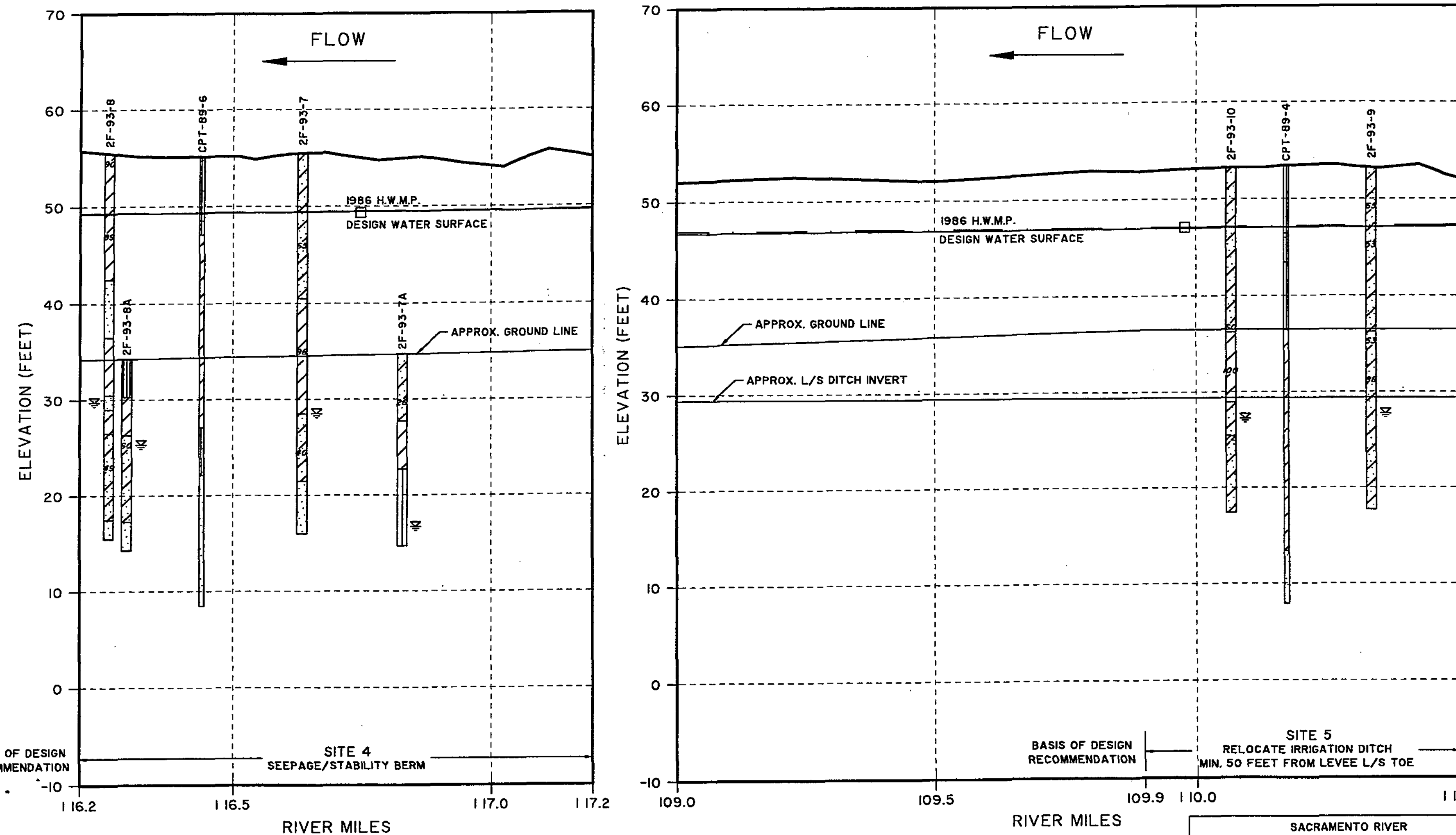
SCALES:
VERTICAL SCALE: 1" = 10'
HORIZONTAL SCALE: 1" = 1000'

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

GEO TECH - SOILS\IWASA\MIDV-F09.DWG\10-03-94

FIGURE 9



NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

SCALES:
VERTICAL SCALE: 1" = 10'
HORIZONTAL SCALE: 1" = 1000'

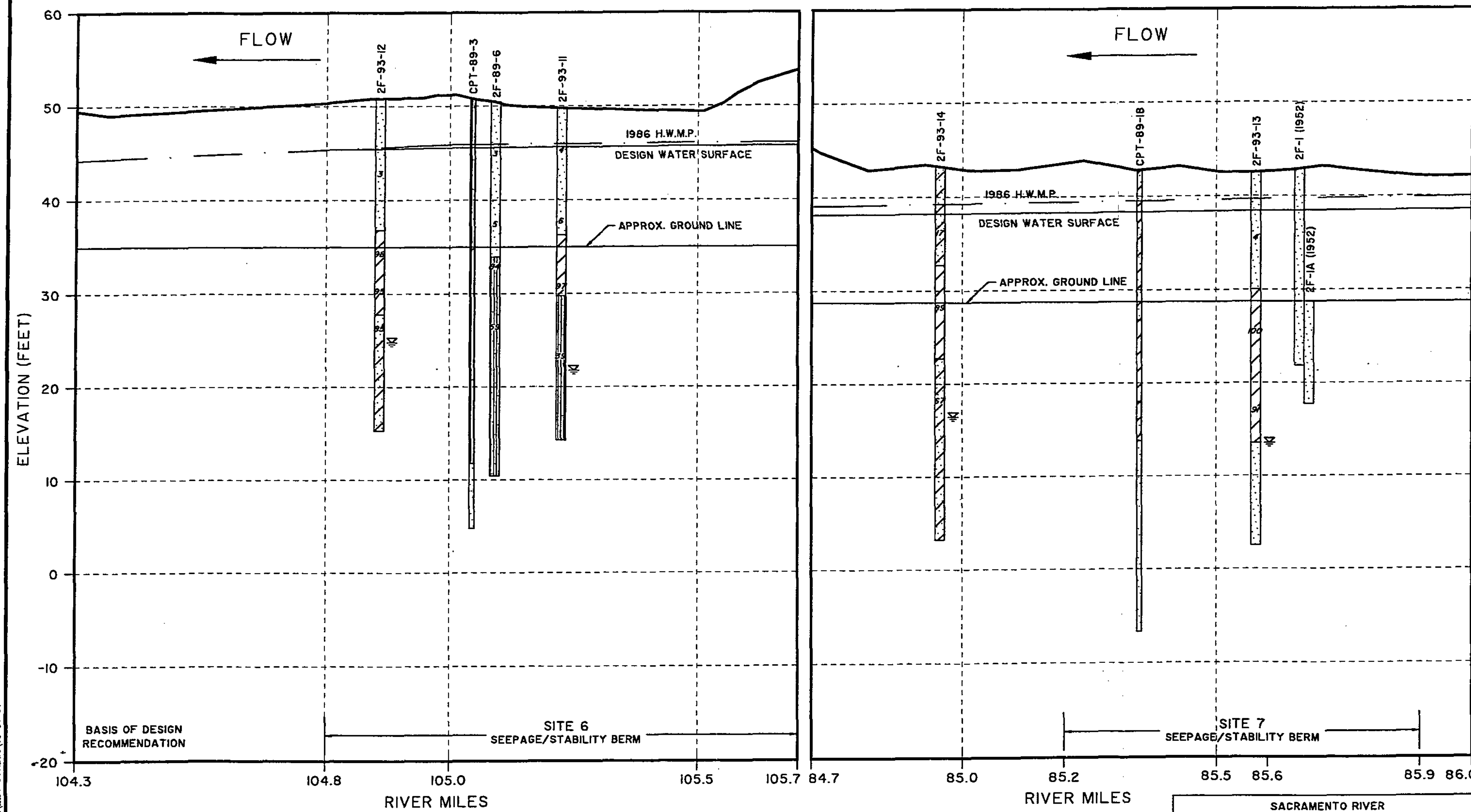
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE PROFILES - R.D. 1500
SACRAMENTO RIVER
LEFT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 10

GEO TECH - SOILS\WASA\MIDV-F11.DWG\10-03-94



NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

SCALES:

VERTICAL SCALE: 1" = 10'
HORIZONTAL SCALE: 1" = 1000'

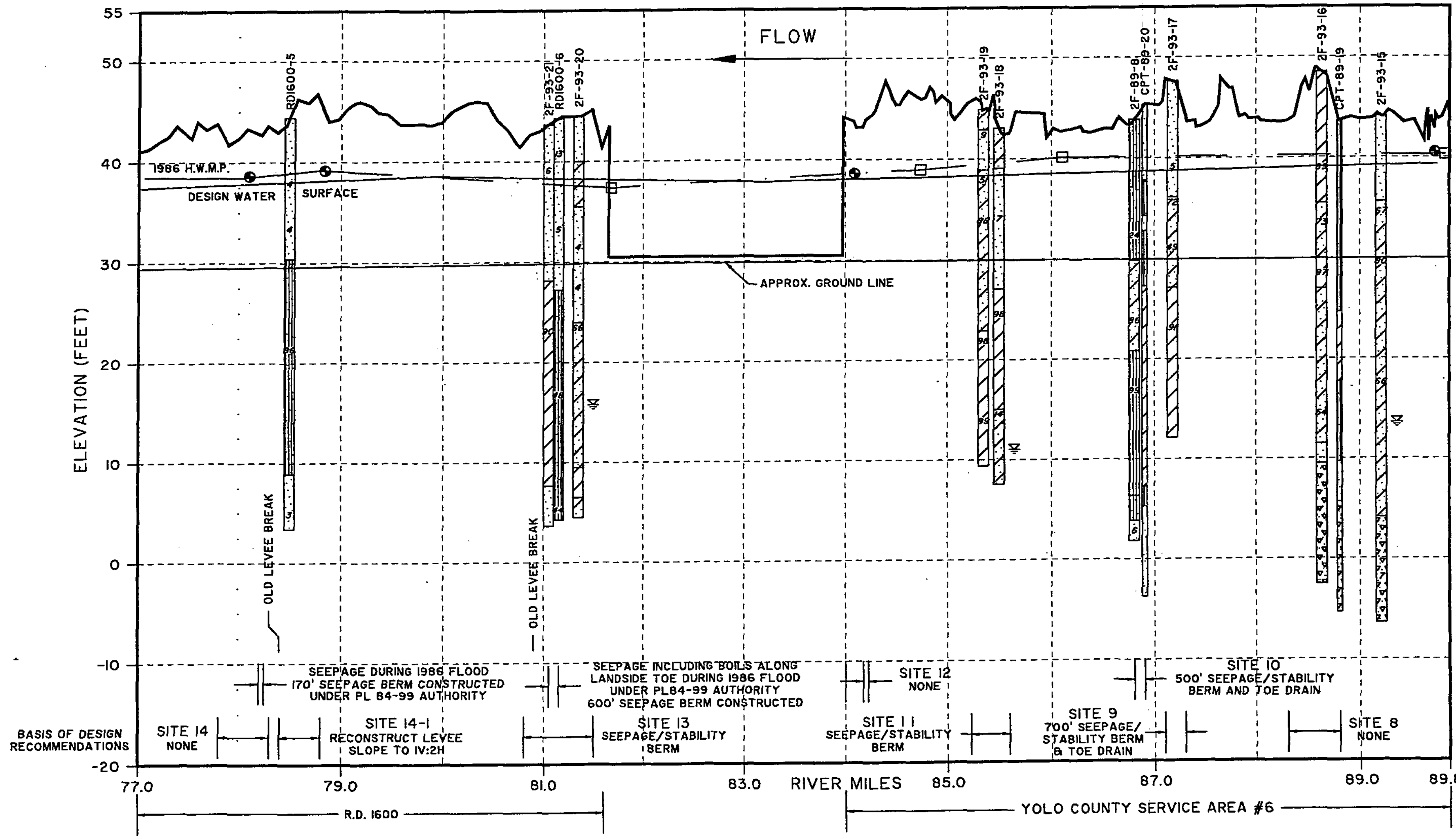
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE PROFILES - R.D. 1500
SACRAMENTO RIVER
LEFT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 11

CSO TECH - SOILS\WASA\MIDV-F11.DWG\10-04-94



SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE PROFILES - R.D. 785, 827 & 1600
SACRAMENTO RIVER
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

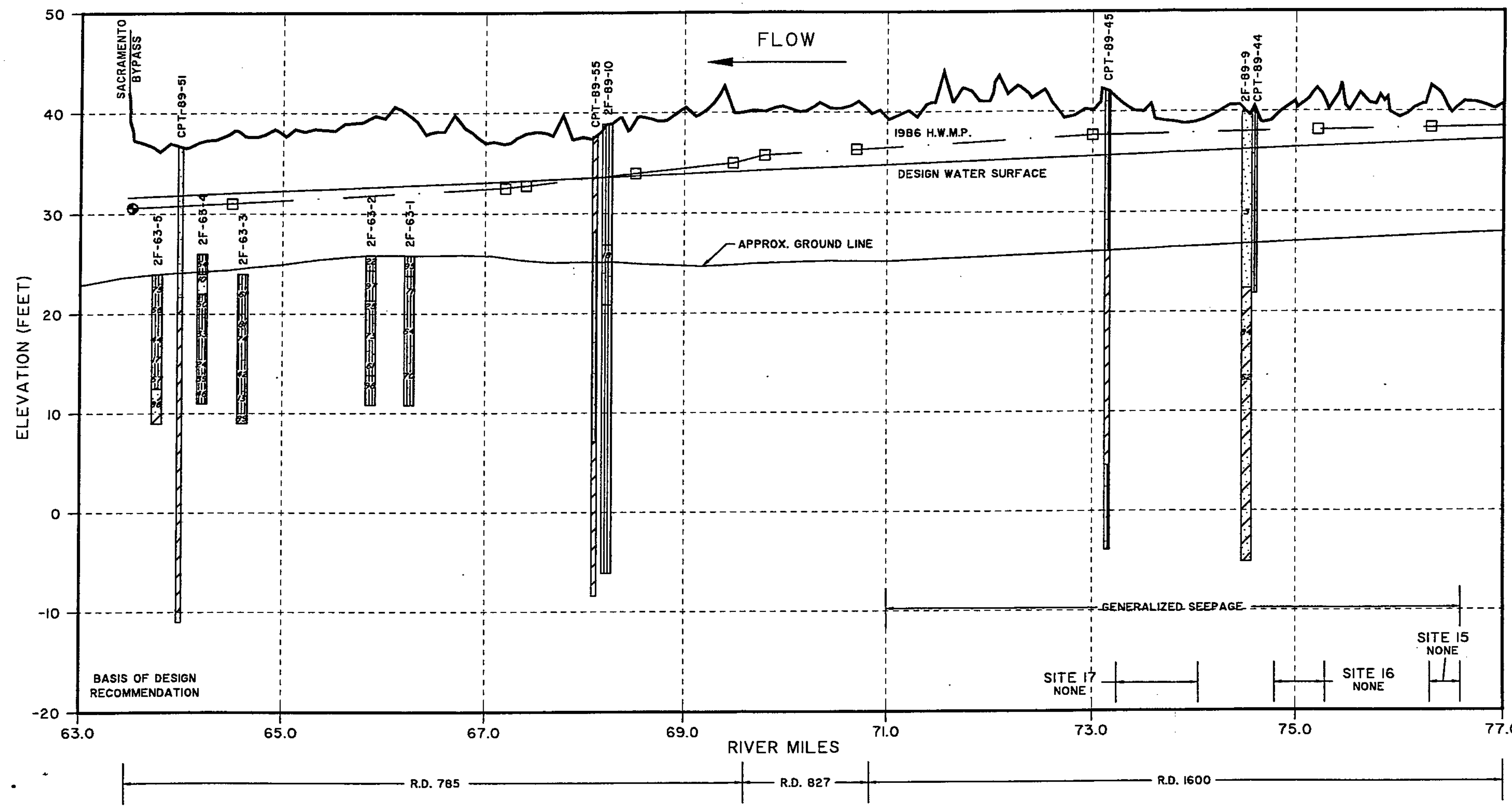
NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

SCALES:

VERTICAL SCALE: 1" = 10'
HORIZONTAL SCALE: 1" = 1 MILE

TECH - SOILS\MASA\MIDV-F12.DWG\10-14-94



NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

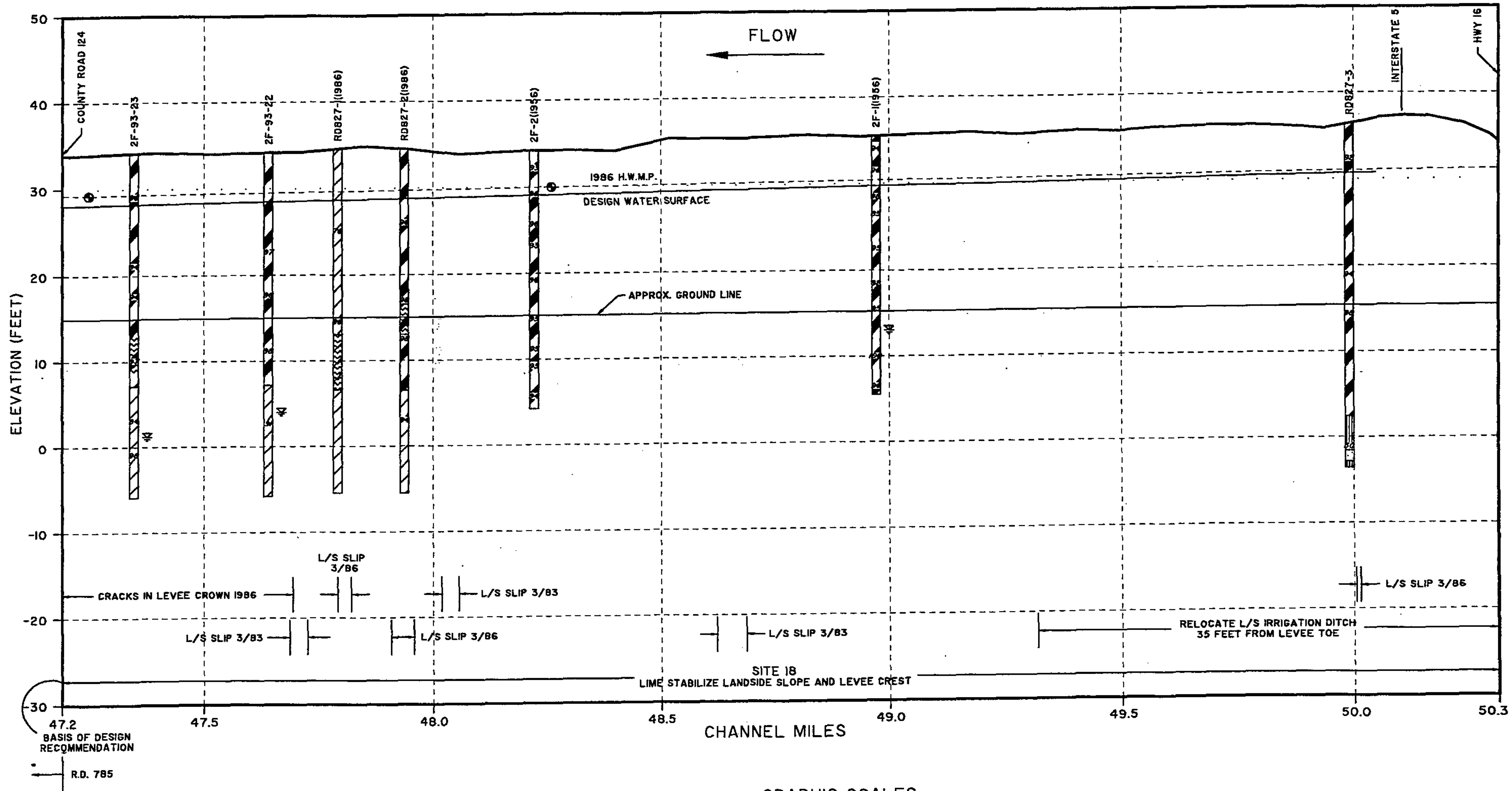
SCALES:

VERTICAL SCALE: 1" = 10'
HORIZONTAL SCALE: 1" = 1 MILE

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION MID VALLEY AREA
LEVEE PROFILES - R.D. 785, 827 & 1600 SACRAMENTO RIVER RIGHT BANK LEVEE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 13

GEO TECH - SOILS\IMASA\MIDV-P13.DWG\10-03-94



GRAPHIC SCALES

VERTICAL 0 5' 10' 20'

HORIZONTAL 0 500' 1000' 2000'

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

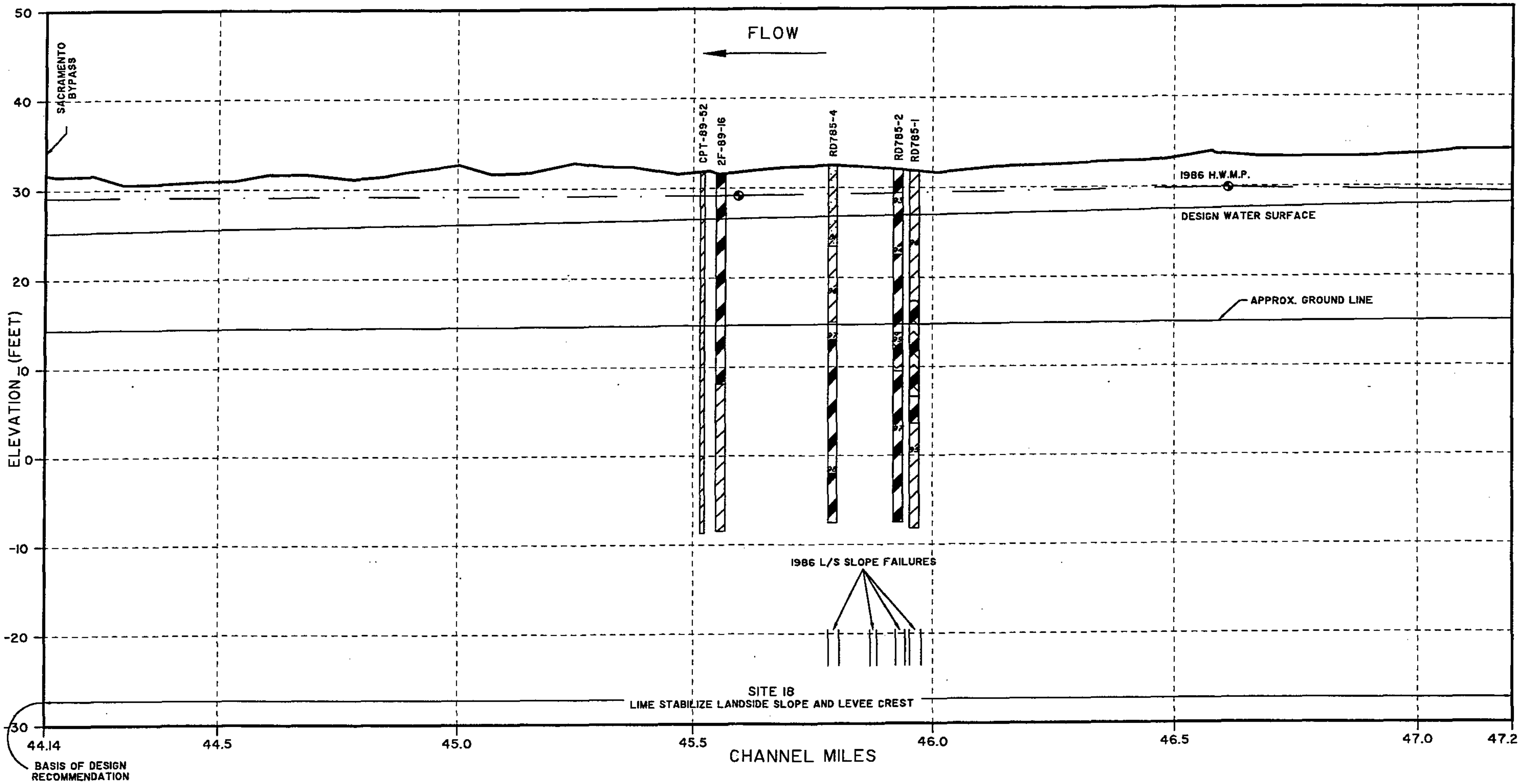
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE PROFILES - R.D. 827
YOLO BYPASS
LEFT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 14

GEO TECH - SOILS\WASA\MIDV-F14.DWG\10-04-94



NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

GRAPHIC SCALES

VERTICAL 0 5' 10' 20'

HORIZONTAL 0 5' 10' 20'

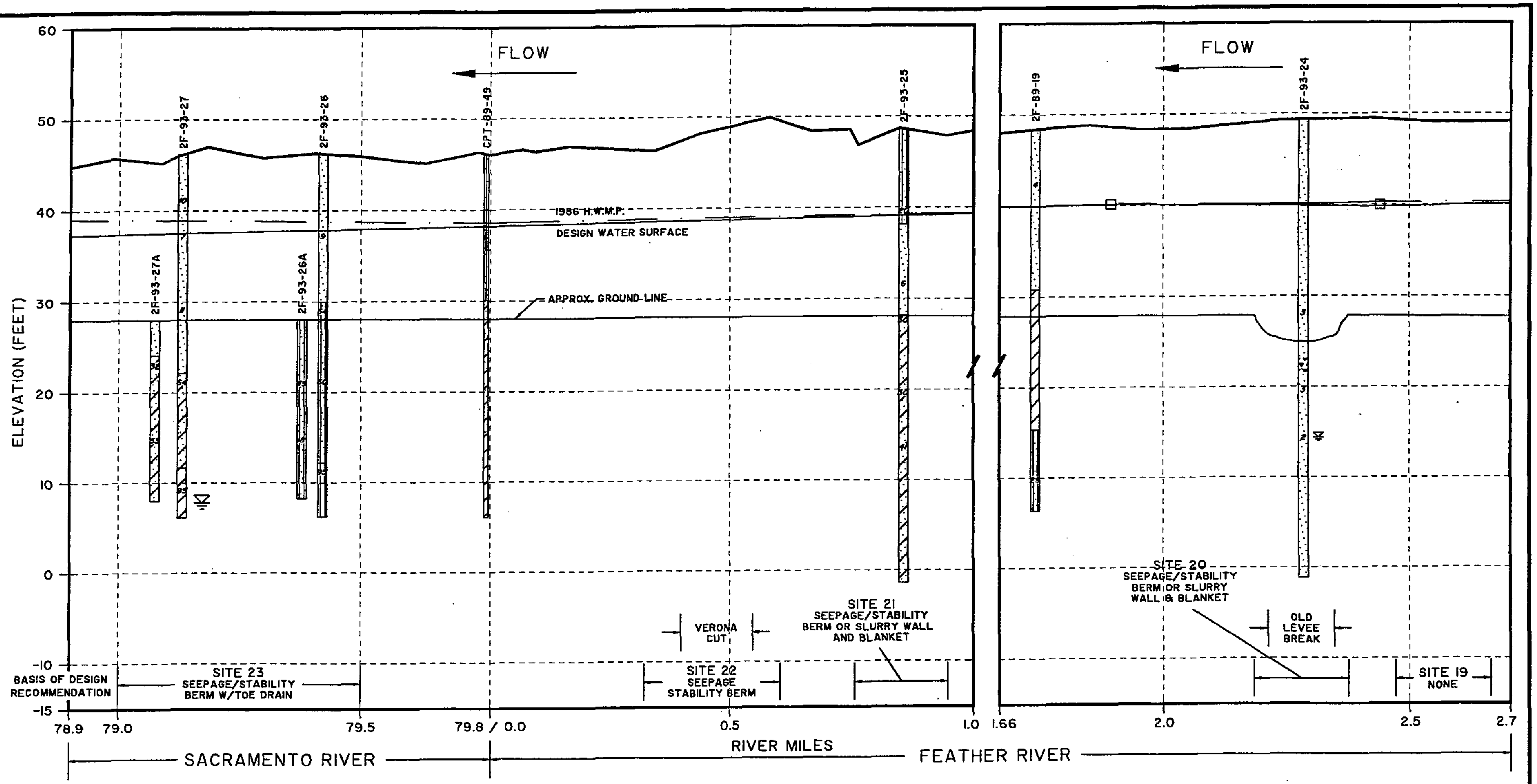
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE PROFILES - R.D. 785
YOLO BYPASS
LEFT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 15

GEO TECH - SOILS\IMASA\MIDV-F15.DWG\10-04-94



GRAPHIC SCALES

0 5' 10' 20'

0 5' 10' 20'

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

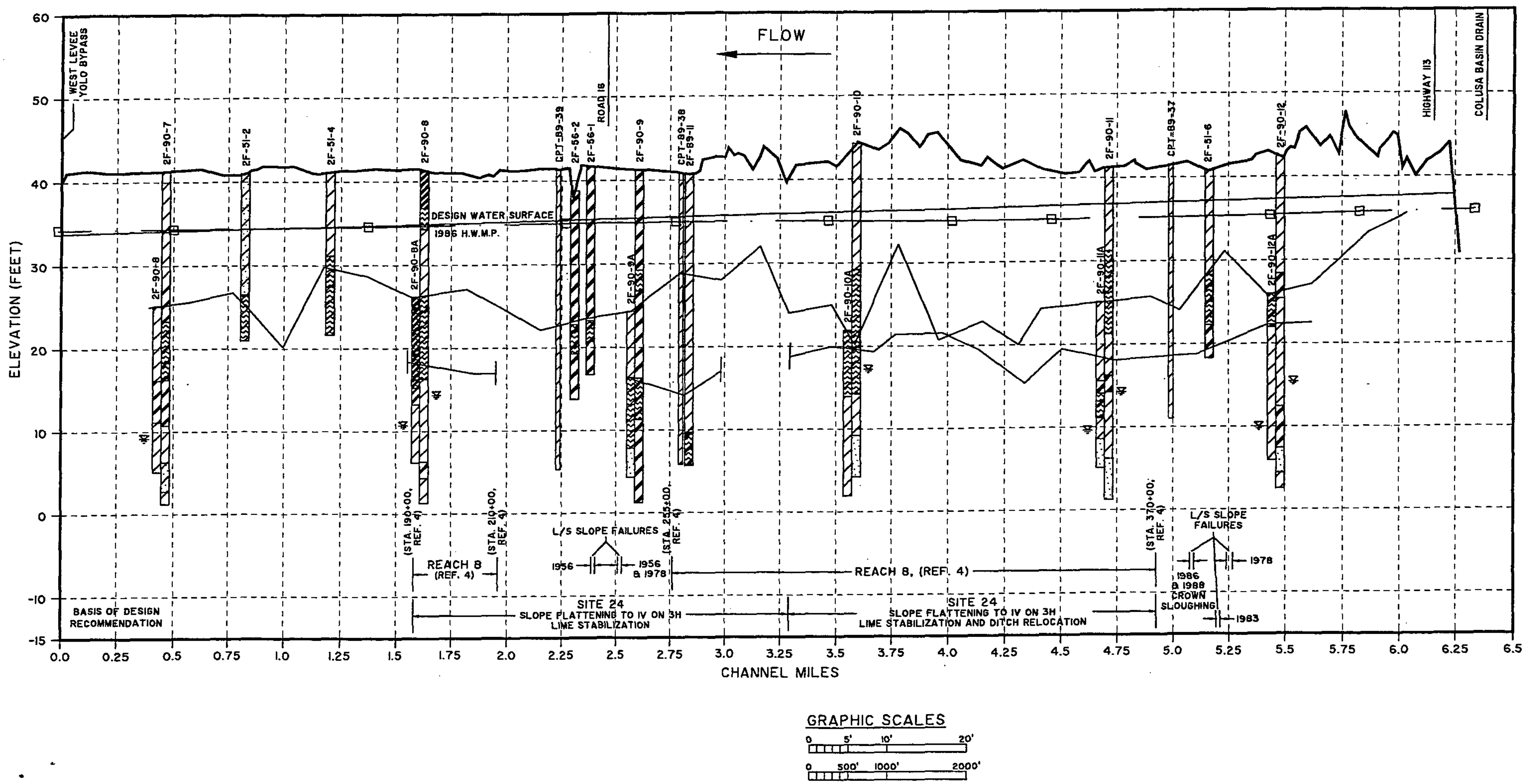
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE PROFILES - R.D. 1001
FEATHER RIVER
LEFT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 16

GEO TECH - SOILS\IWASA\MIDV-F16.DWG\10-04-94



NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

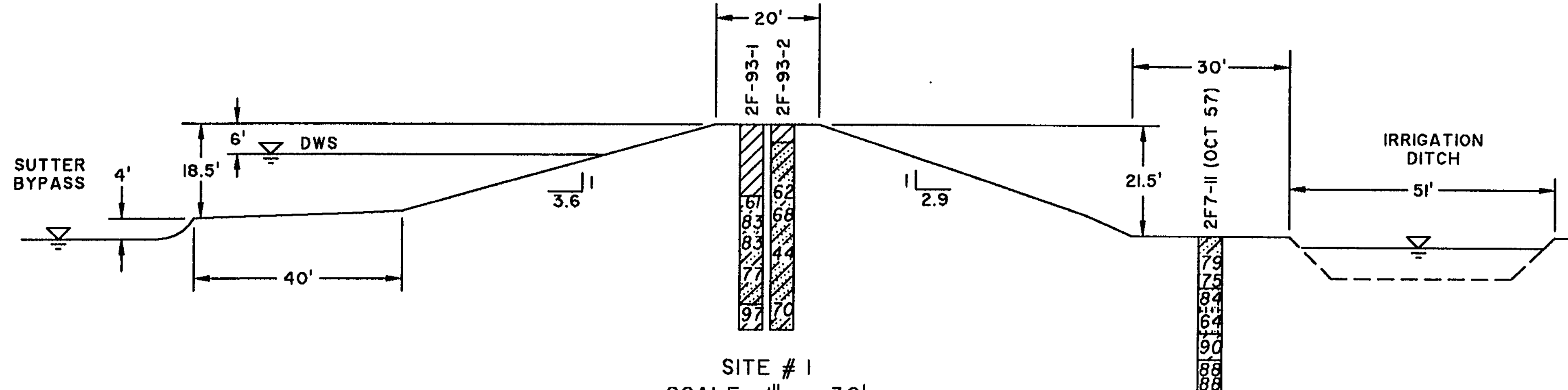
LEVEE PROFILES
SACRAMENTO RIVER WESTSIDE LEVEE DISTRICT
KNIGHTS LANDING RIDGE CUT
EAST BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

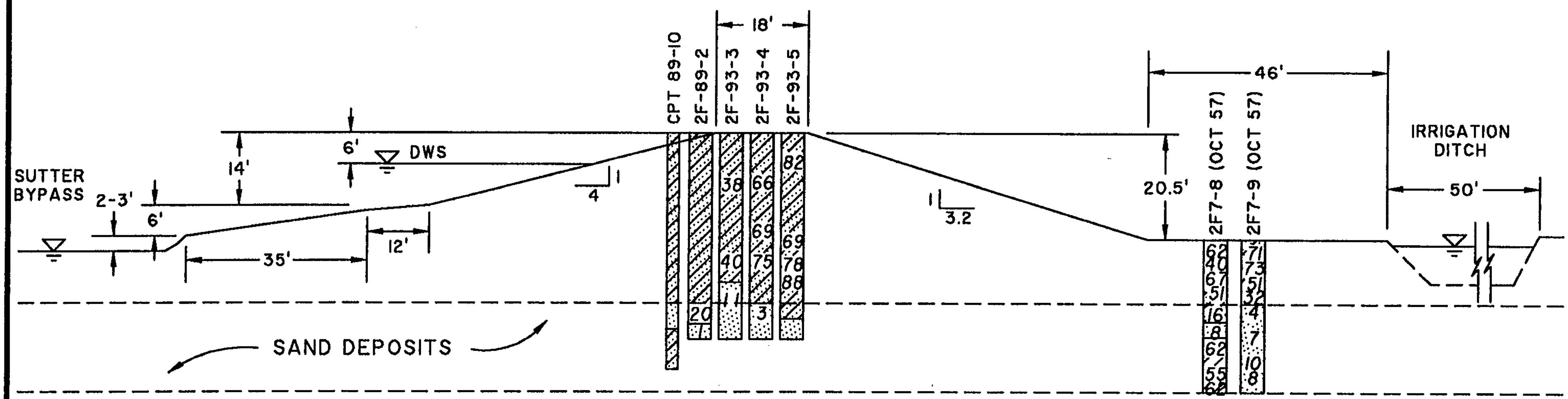
FIGURE 17

GEO TECH - SOILS\IMASA\MIDV-F17.DWG\10-26-94

GEO TECH - SOILS\IWASA\MIDV-F18.DWG\10-14-94



SITE # 1
SCALE: 1" = 30'



SITE # 2
SCALE: 1" = 30'

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

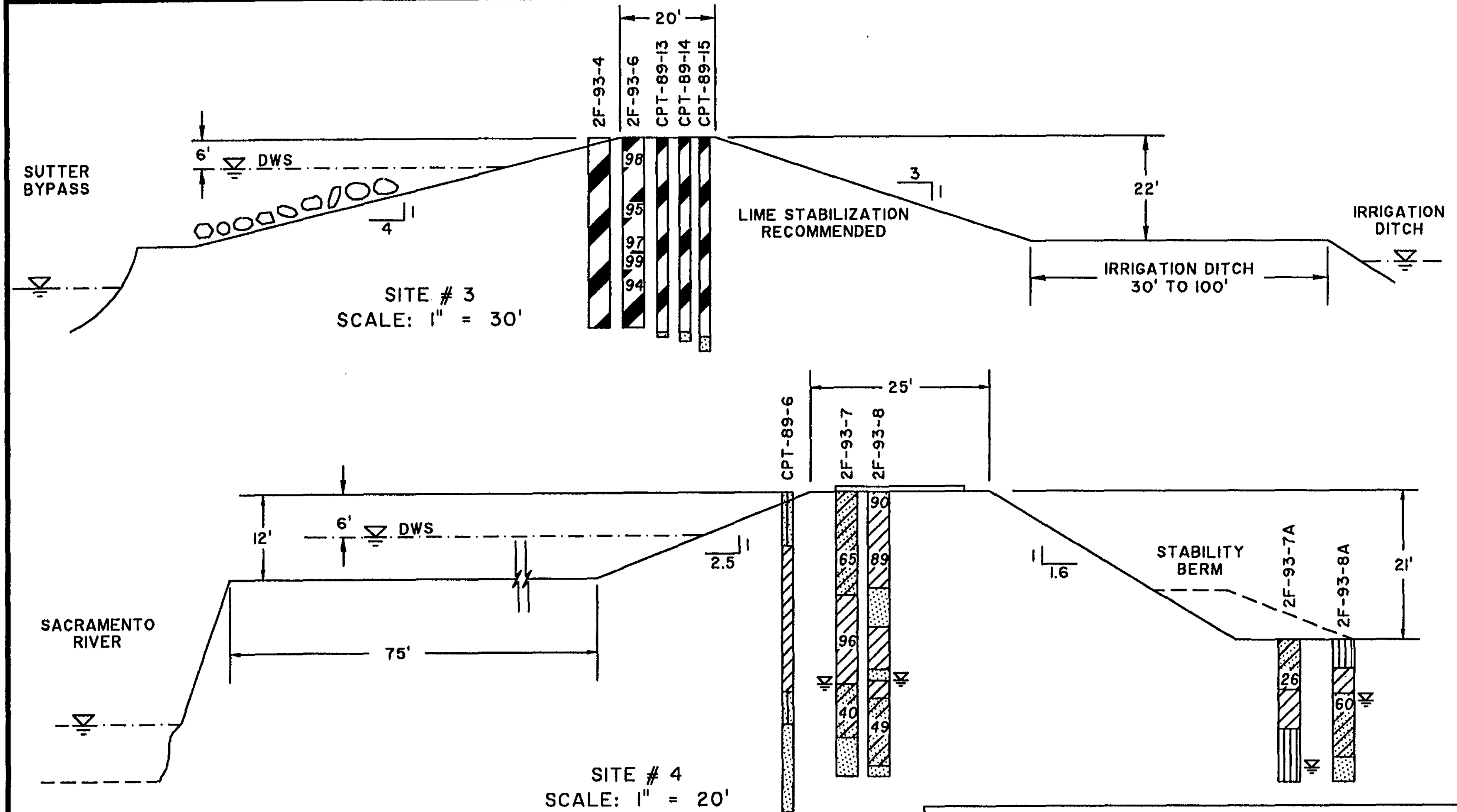
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1500
SUTTER BYPASS
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 18

GEO TECH - SOILS\IWASA\MIDV-F19.DWG\10-14-94



NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

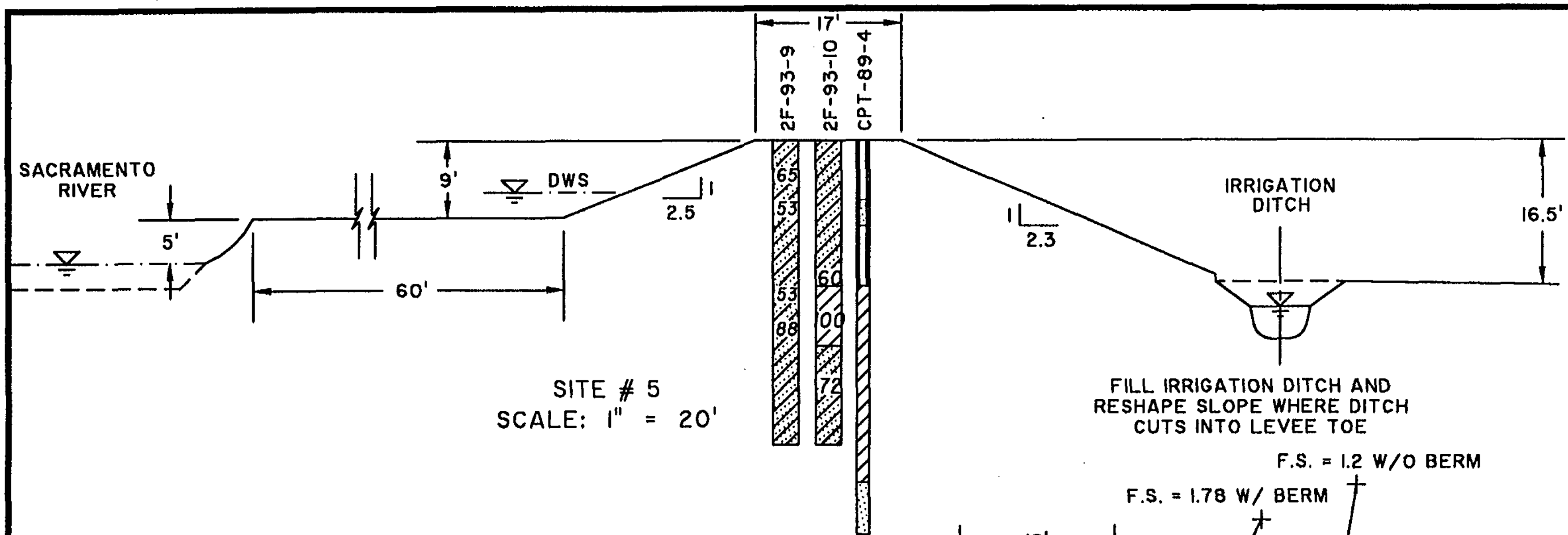
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1500
SUTTER BYPASS & SACRAMENTO RIVER
RIGHT BANK LEVEES

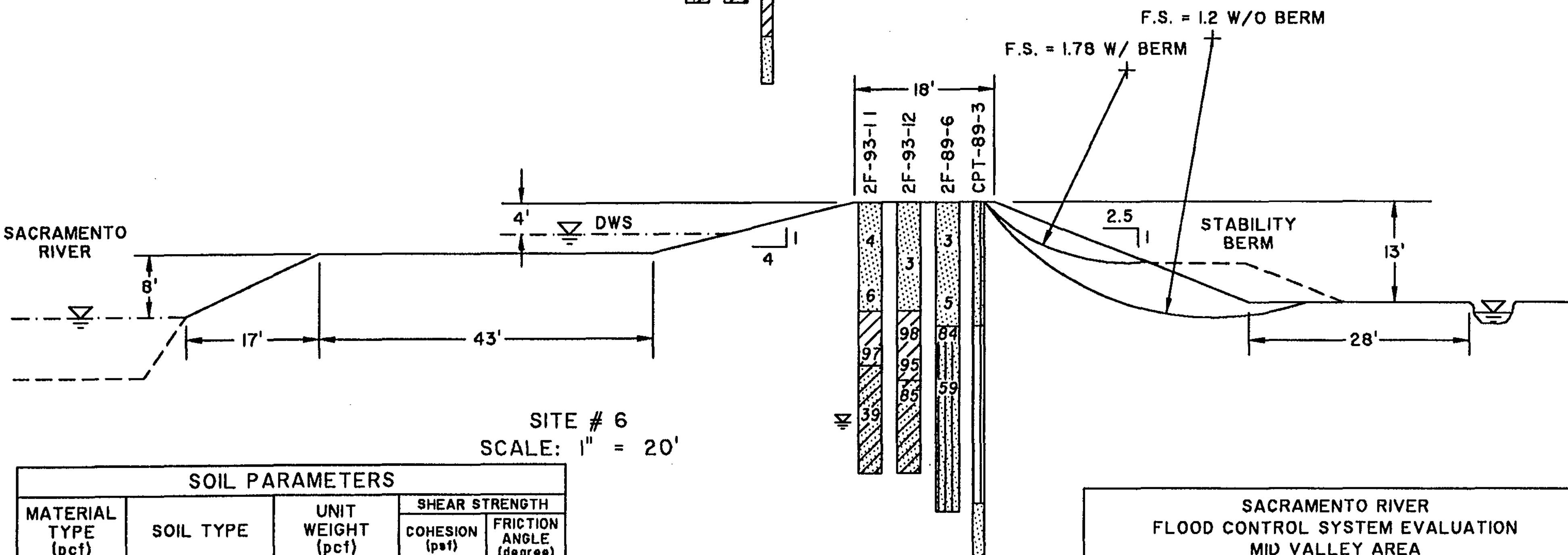
SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 19

GEO TECH - SOILS\IWASA\MIDV-F20.DWG\10-26-94



SITE # 5
SCALE: 1" = 20'



SITE # 6
SCALE: 1" = 20'

SOIL PARAMETERS				
MATERIAL TYPE (pcf)	SOIL TYPE	UNIT WEIGHT (pcf)	SHEAR STRENGTH	
			COHESION (psf)	FRICTION ANGLE (degree)
①	LEVEE SAND (SP)	105 MOIST 115 SATURATED	-	28°

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

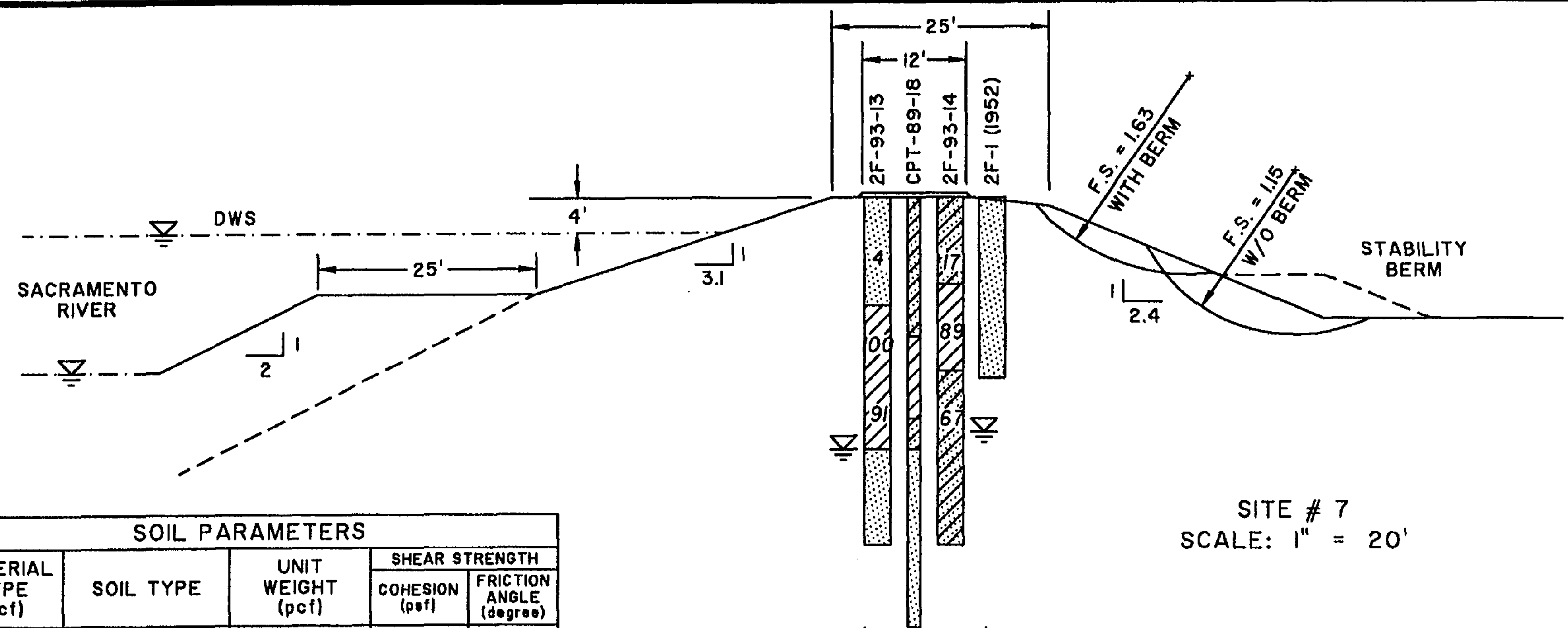
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1500
SACRAMENTO RIVER
LEFT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

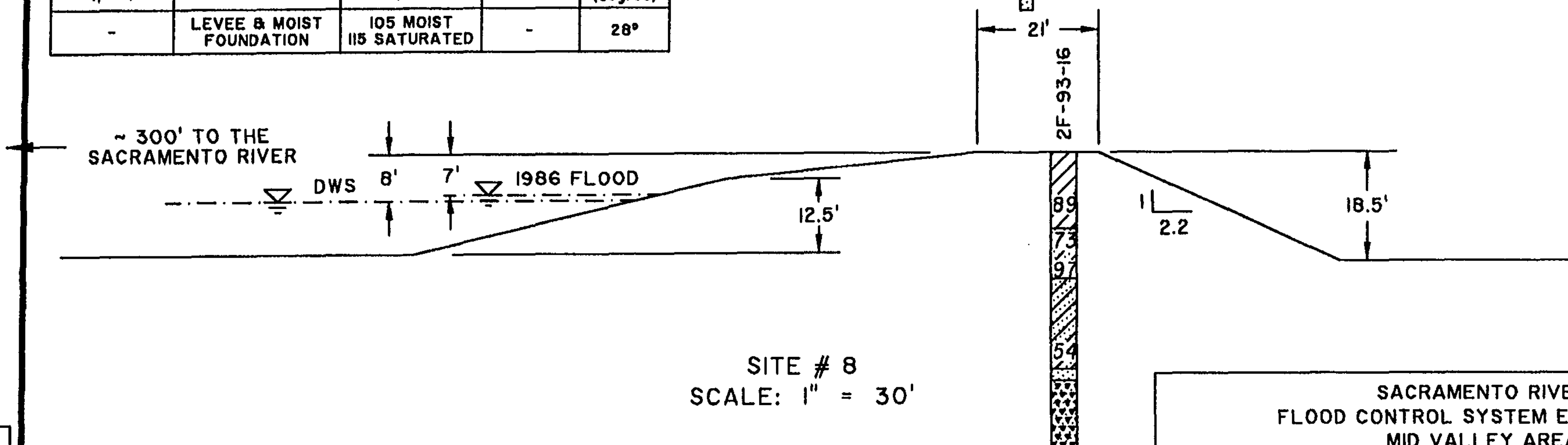
FIGURE 20

GEO TECH - SOILS\IWASA\MIDV-F21.DWG\10-26-94



SITE # 7
SCALE: 1" = 20'

SOIL PARAMETERS				
MATERIAL TYPE (pcf)	SOIL TYPE	UNIT WEIGHT (pcf)	SHEAR STRENGTH	
			COHESION (psf)	FRICTION ANGLE (degree)
-	LEVEE & MOIST FOUNDATION	105 MOIST 115 SATURATED	-	28°



SITE # 8
SCALE: 1" = 30'

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

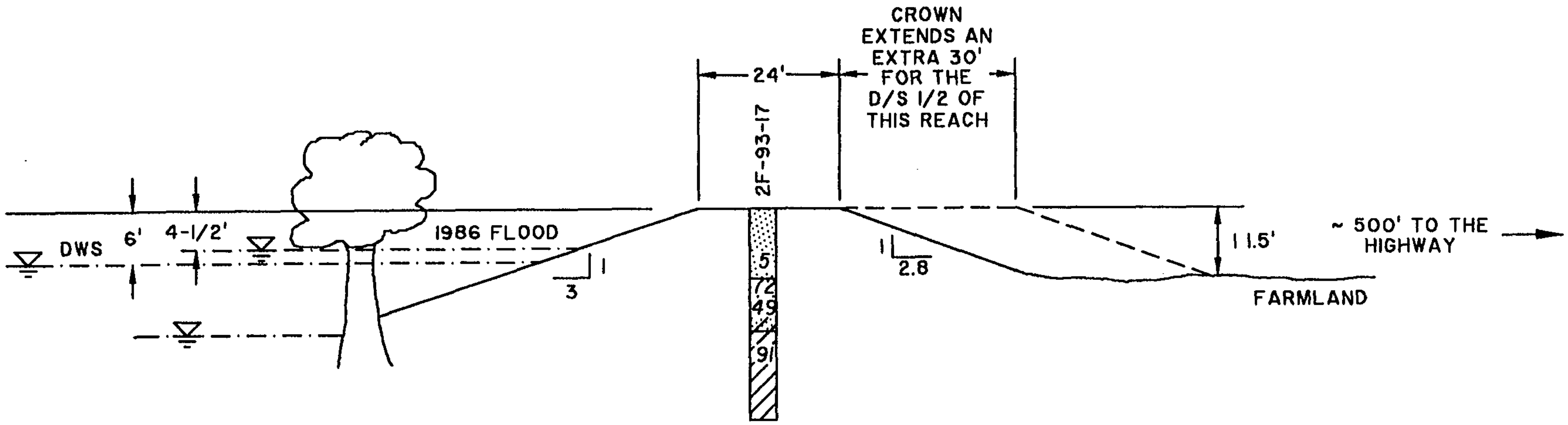
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1500 & YOLO COUNTY
SACRAMENTO RIVER
LEFT & RIGHT BANK OF LEVEE

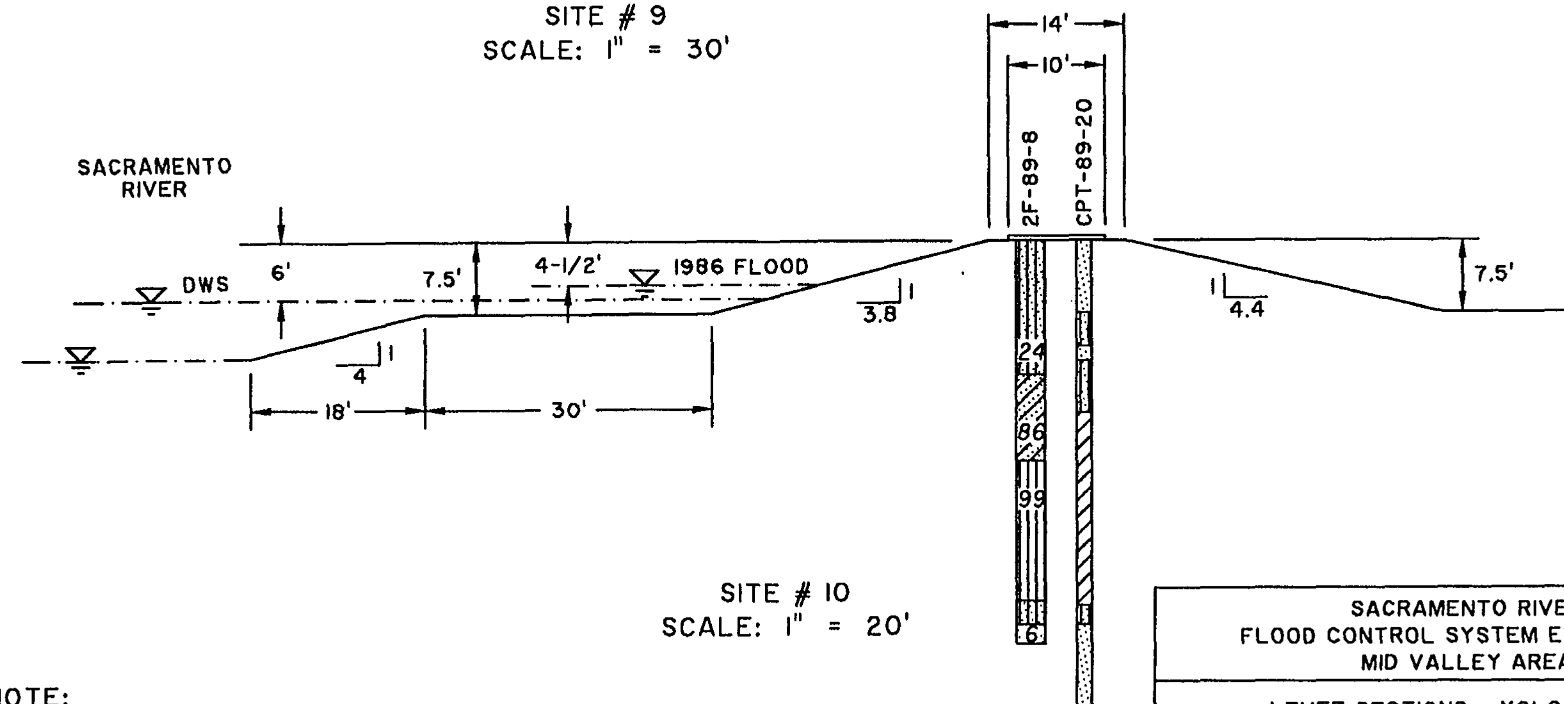
SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 21

GEO TECH - SOILS\IWASA\MIDV-F22.DWG\10-26-94



SITE # 9
SCALE: 1" = 30'



SITE # 10
SCALE: 1" = 20'

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

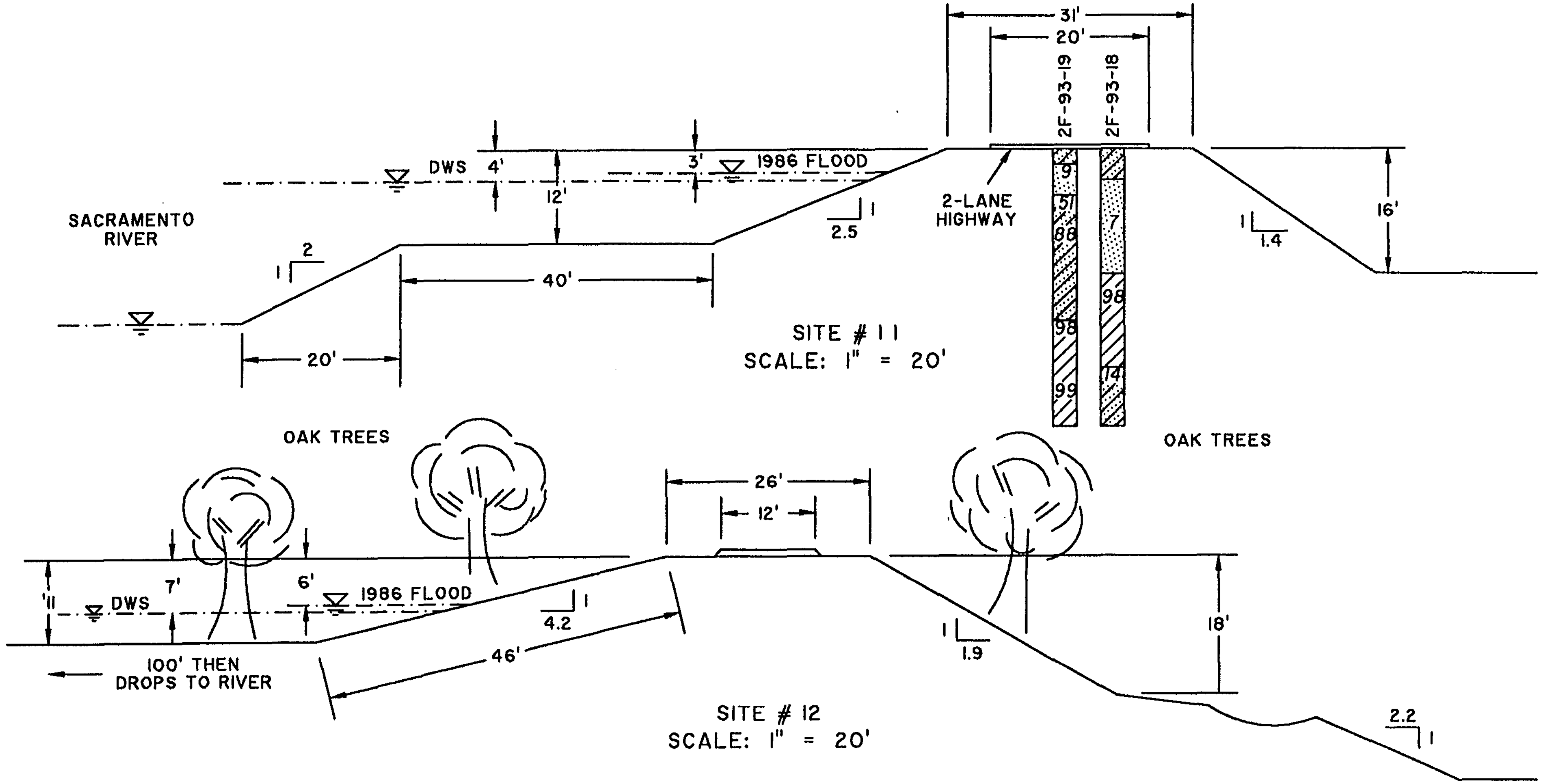
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - YOLO COUNTY
SACRAMENTO RIVER
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 22

CEO TECH - SOILS\IWASA\MIDV-F23.DWC\10-26-94



NOTE:

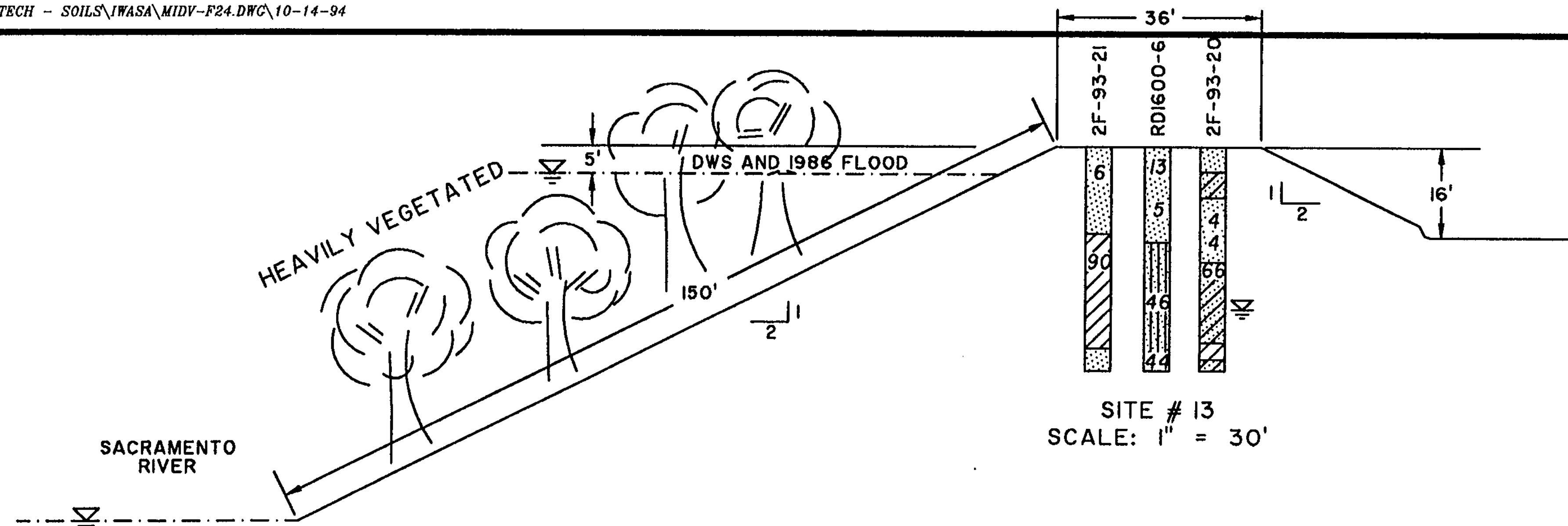
1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

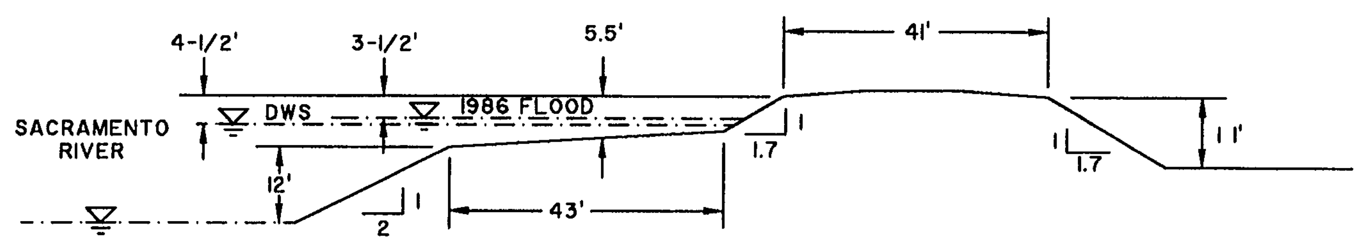
LEVEE SECTIONS - YOLO COUNTY
SACRAMENTO RIVER
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 23



SITE # 13
SCALE: 1" = 30'



SITE # 14
SCALE: 1" = 30'

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

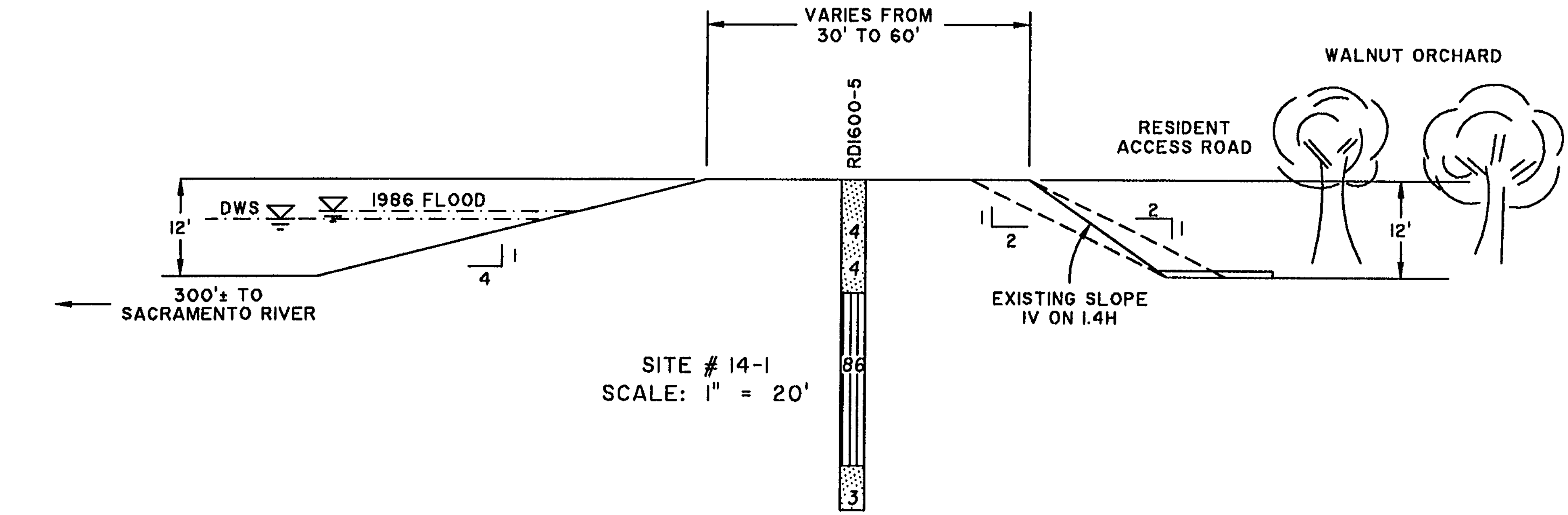
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1600
SACRAMENTO RIVER
RIGHT BANK LEVEE

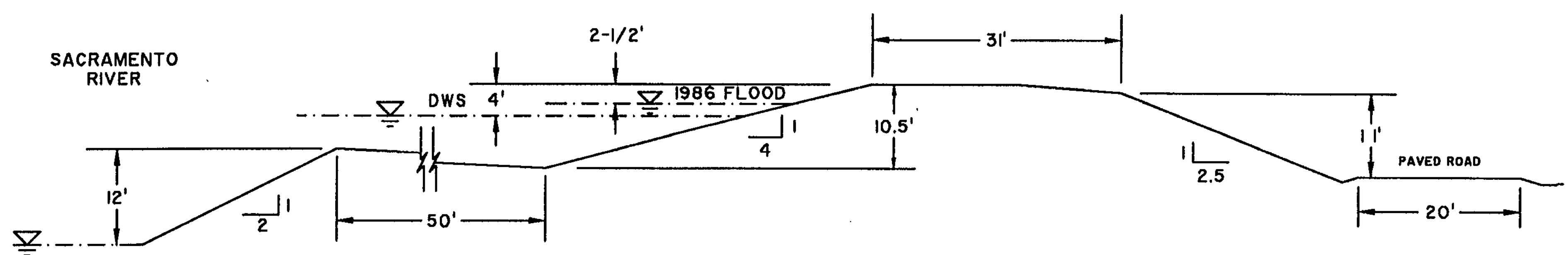
SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 24

GEO TECH - SOILS\IWASA\MIDV-F25.DWG\10-14-94



SITE # 14-1
SCALE: 1" = 20'



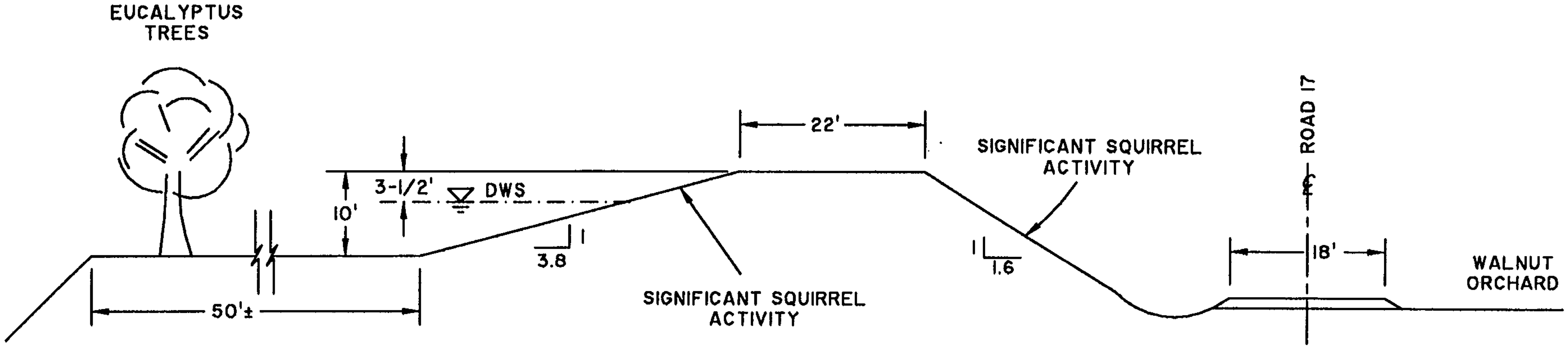
SITE # 15
SCALE: 1" = 20'

NOTE:

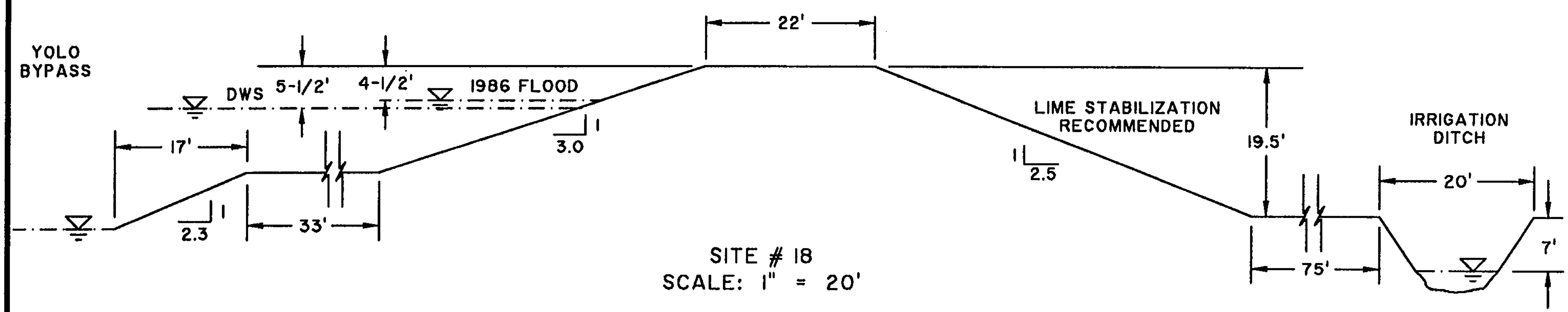
1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION MID VALLEY AREA
LEVEE SECTIONS - R.D. 1600 SACRAMENTO RIVER RIGHT BANK LEVEE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 25



SITE # 17
SCALE: 1" = 20'



SITE # 18
SCALE: 1" = 20'

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

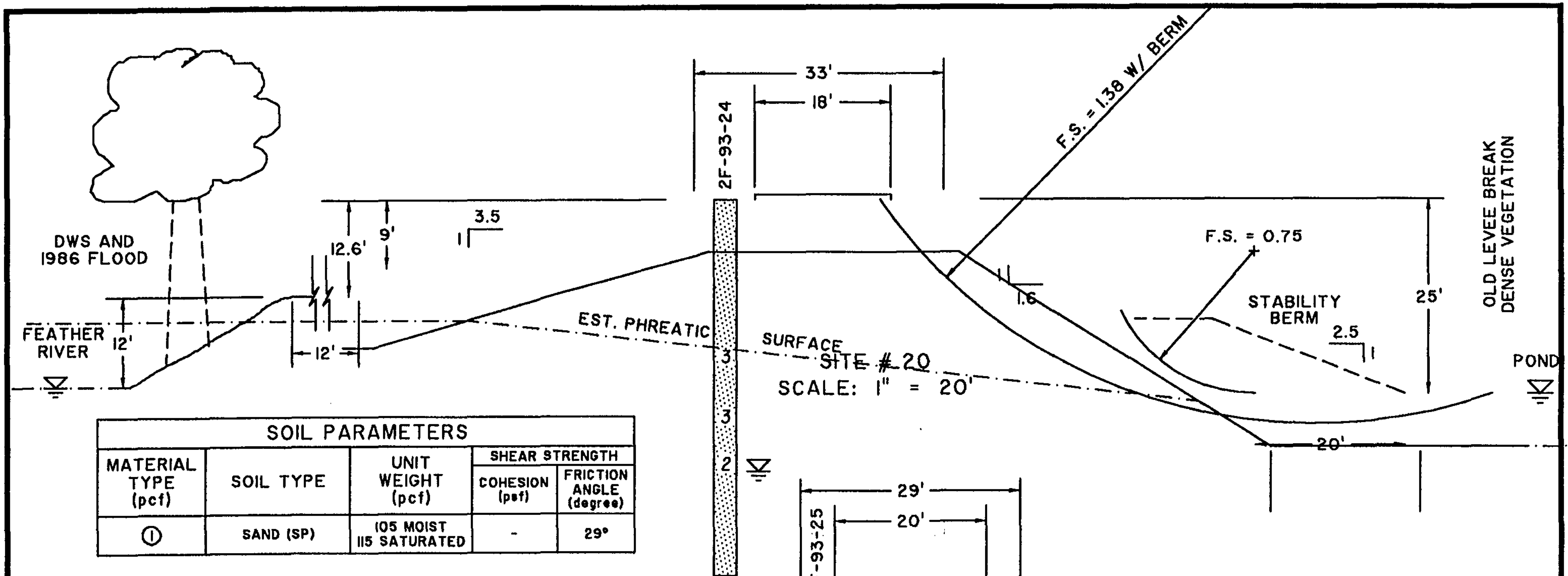
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1600 AND R.D. 827
SACRAMENTO RIVER RIGHT
BANK LEVEE AND YOLO
BYPASS EAST BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

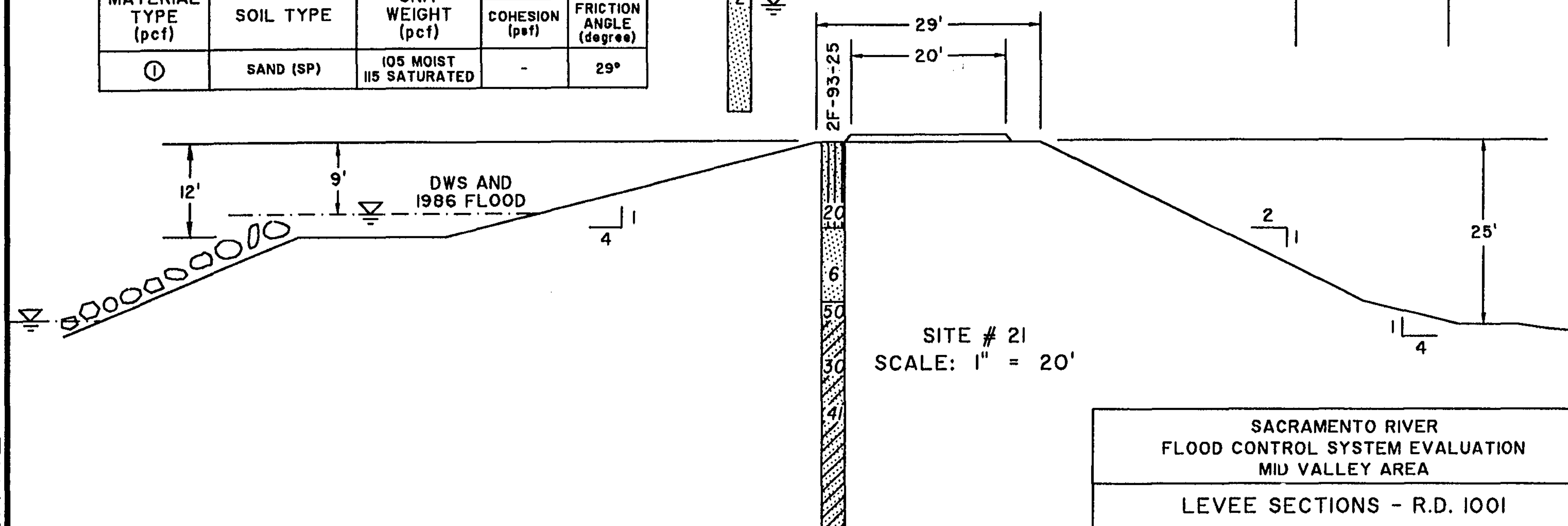
FIGURE 26

GEO TECH - SOILS\IWASA\MIDV-F27.DWG\10-14-94



SITE # 20
SCALE: 1" = 20'

SOIL PARAMETERS				
MATERIAL TYPE (pcf)	SOIL TYPE	UNIT WEIGHT (pcf)	SHEAR STRENGTH	
			COHESION (psf)	FRICTION ANGLE (degree)
1	SAND (SP)	105 MOIST 115 SATURATED	-	29°



SITE # 21
SCALE: 1" = 20'

NOTE:

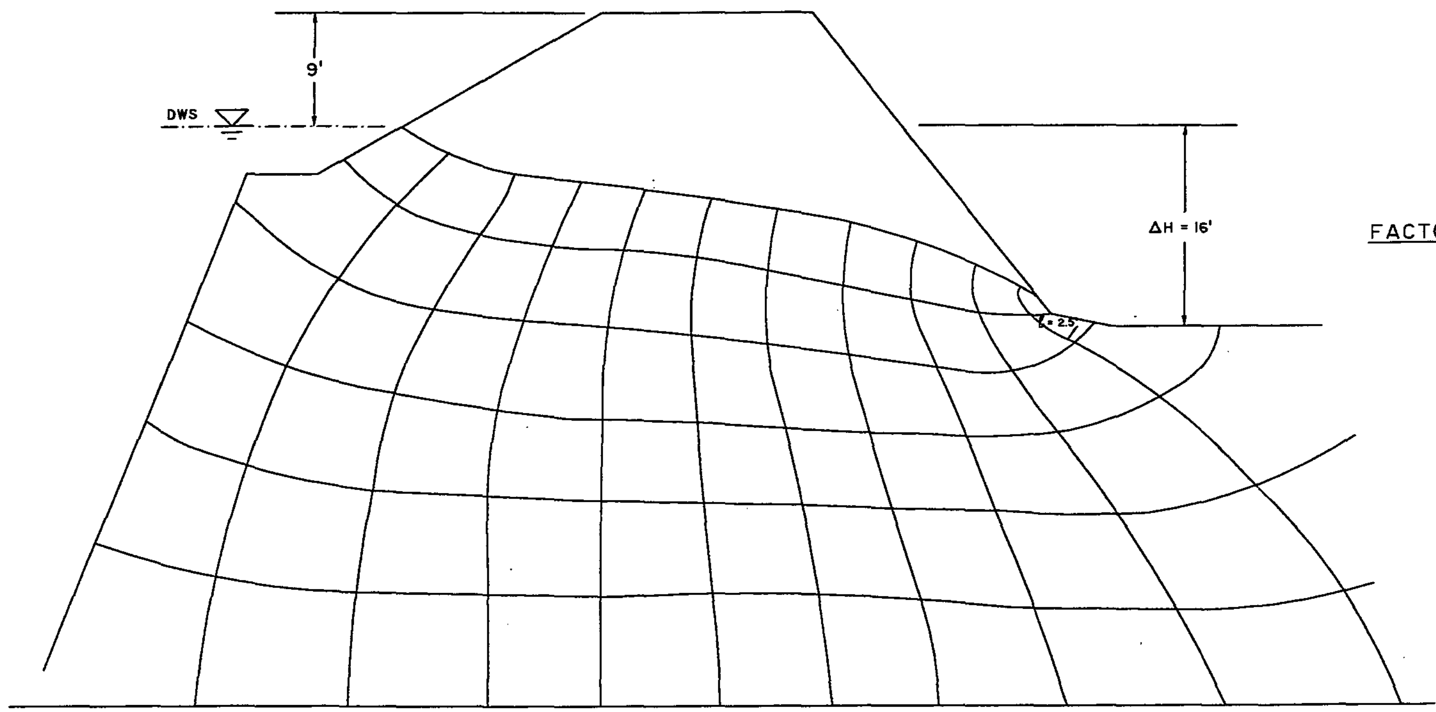
1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1001
FEATHER RIVER
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 27



SITE 20
FLOW NET ANALYSIS

FACTOR OF SAFETY AGAINST PIPING

$n_d = 11.0$

$\frac{\Delta H}{n_d} = \frac{16}{11} = 1.45'$ per drop

$\ell = 2.5'$

$i_e = \frac{(0.75) \times 1.45}{2.5} = 0.43$

$i_c = \frac{G_s - 1}{1+e}$

$i_c = \frac{2.65 - 1}{1 + 0.7} = 0.97$

$e \cong 0.7$ (est.)

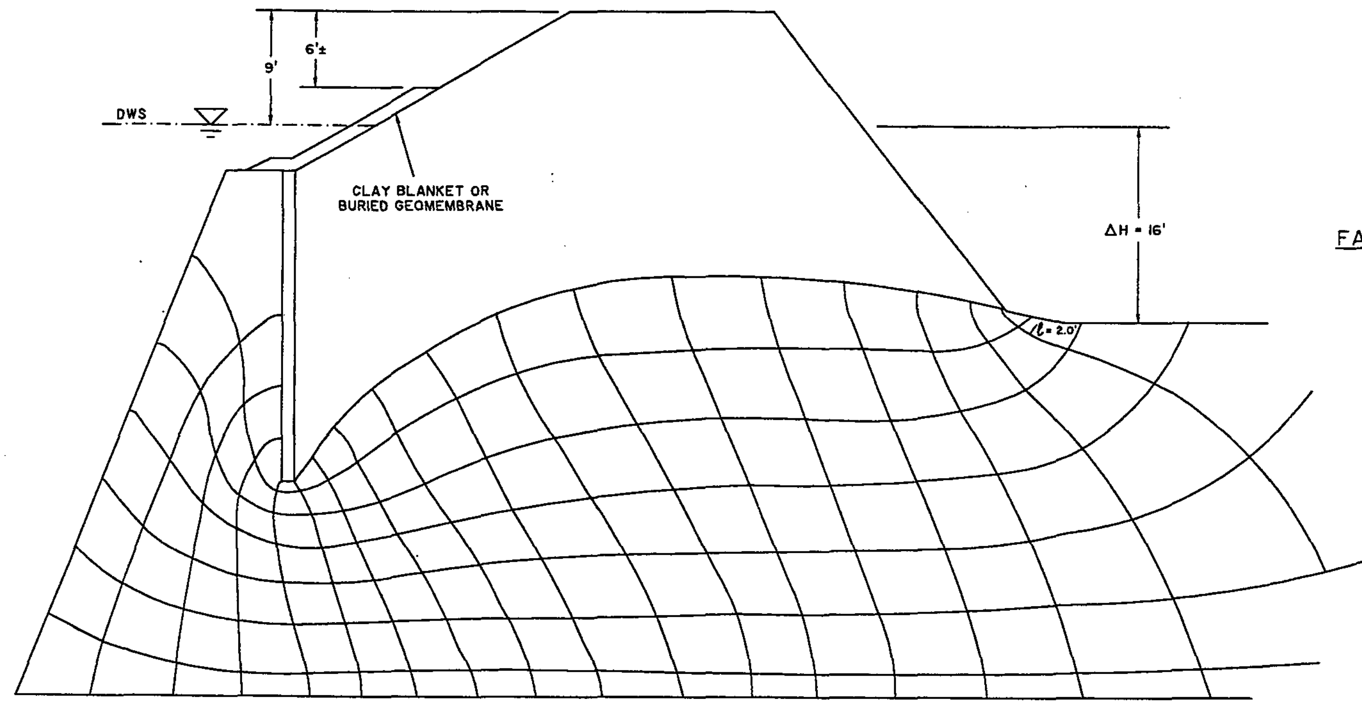
$F.S. = \frac{i_c}{i_e} = \frac{0.97}{0.43} = 2.3$

SCALE:
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION MID VALLEY AREA
LEVEE SECTIONS - R.D. 1001 FEATHER RIVER RIGHT BANK LEVEE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 28

GEO TECH - SOILS\IWASA\MIDV-F28.DWG\10-14-94



FACTOR OF SAFETY AGAINST PIPING

$n_d = 17.5$

$\frac{\Delta H}{n_d} = \frac{16}{17.5} = 0.91'$ per drop

$\ell = 2.0'$

$i_e = \frac{(1/2) \times 0.91}{2.0} = 0.23$

$i_c = \frac{G_s - 1}{1+e}$

$i_c = \frac{2.65 - 1}{1 + 0.7} = 0.97$

$e \cong 0.7$ (est.)

$F.S. = \frac{i_c}{i_e} = \frac{0.97}{0.23} = 4.2$

SITE 20
FLOW NET ANALYSIS

SCALE:
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

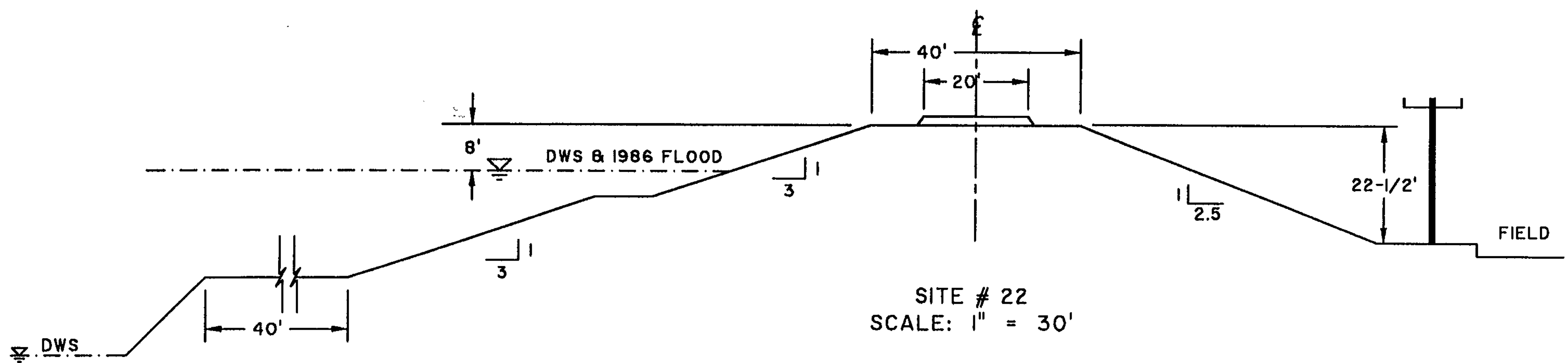
LEVEE SECTIONS - R.D. 1001
FEATHER RIVER
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 29

GEO TECH - SOILS\WASA\MIDV-F29.DWG\10-14-94

GEO TECH - SOILS\IWASA\MIDV-F30.DWG\10-14-94



SITE # 22
SCALE: 1" = 30'

NOTE:

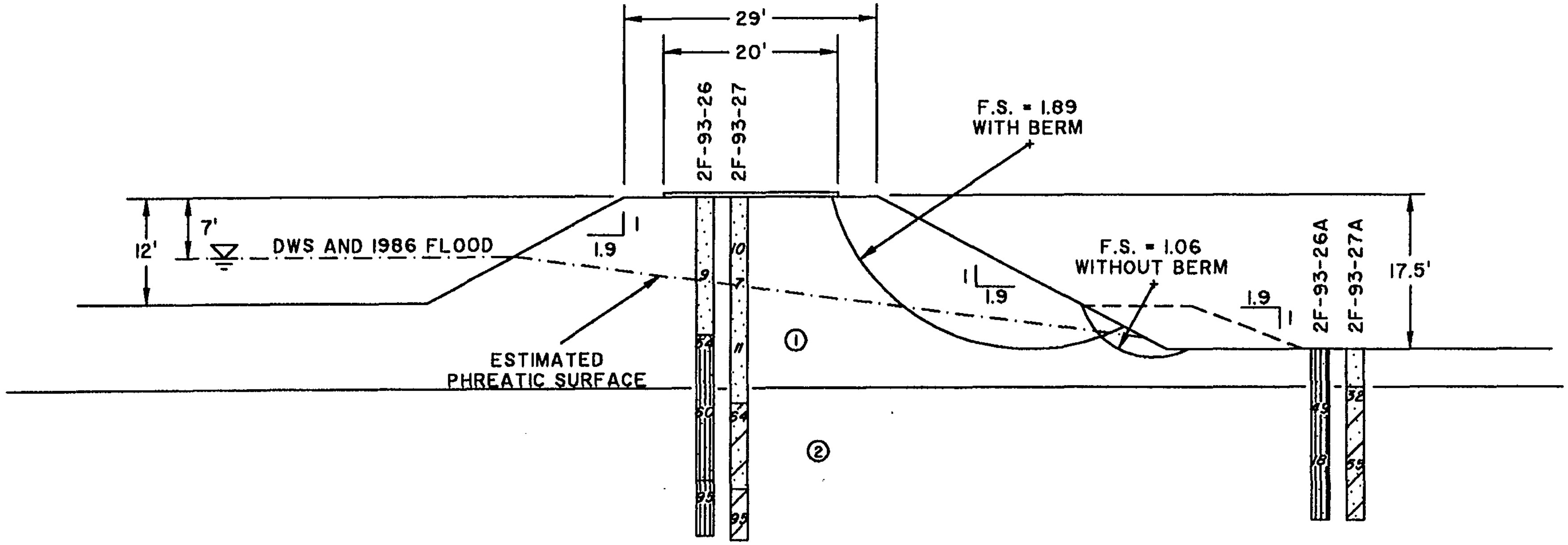
1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1001
FEATHER RIVER
LEFT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 30



SITE # 23
SCALE: 1" = 20'

SOIL PARAMETERS				
MATERIAL TYPE (pcf)	SOIL TYPE	UNIT WEIGHT (pcf)	SHEAR STRENGTH	
			COHESION (psf)	FRICTION ANGLE (degree)
①	SAND (SP)	105 MOIST 115 SATURATED	0	30
②	SANDY SILT (ML)/ SANDY CLAY (CL)	115 SATURATED	500	28

NOTE:

1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.

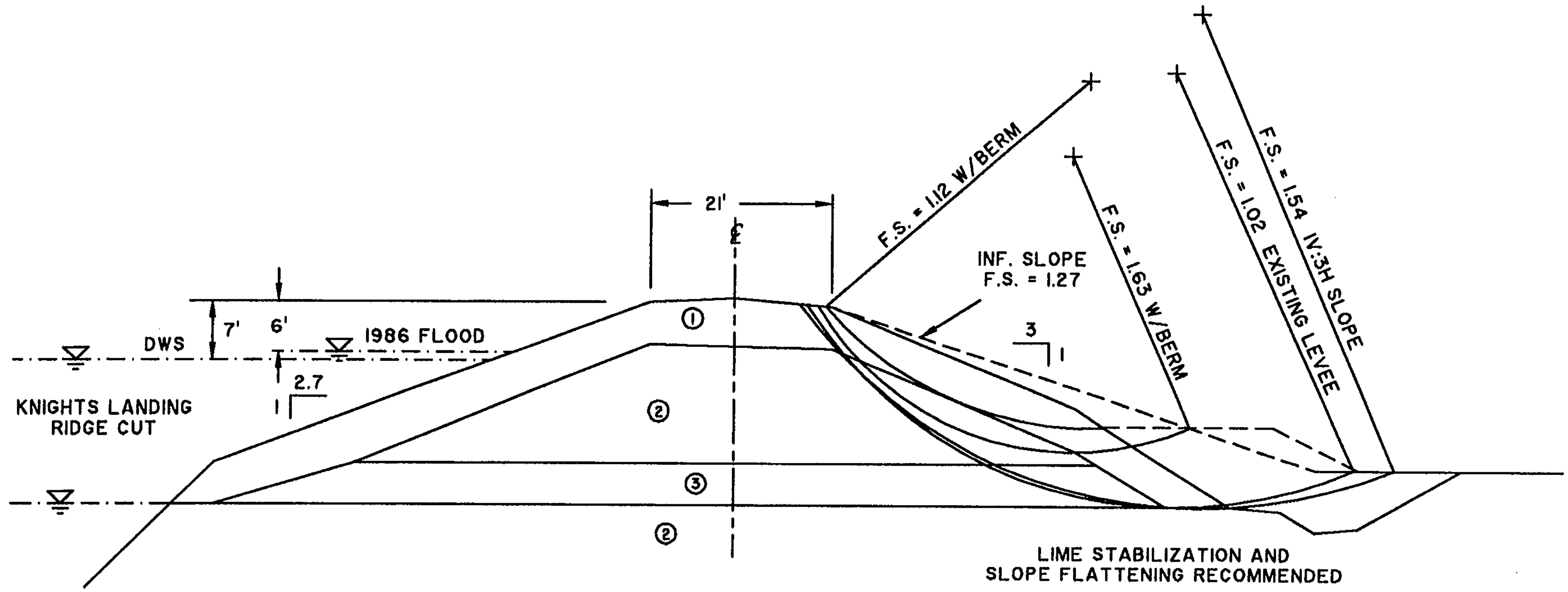
SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS - R.D. 1001
FEATHER RIVER
RIGHT BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 31

GEO TECH - SOILS\IWASA\MIDV-F32.DWG\10-26-94



SITE # 24
SCALE: 1" = 20'

SOIL PARAMETERS				
MATERIAL TYPE (pcf)	SOIL TYPE	UNIT WEIGHT (pcf)	SHEAR STRENGTH	
			COHESION (psf)	FRICTION ANGLE (degree)
①	WEATHERED FAT CLAY (CH)	115 MOIST	-	23°
②	FAT CLAY, (CH)	115 MOIST	-	28°
③	FAT CLAY, (CH) ORGANICS	115 SATURATED	-	18°

NOTE:

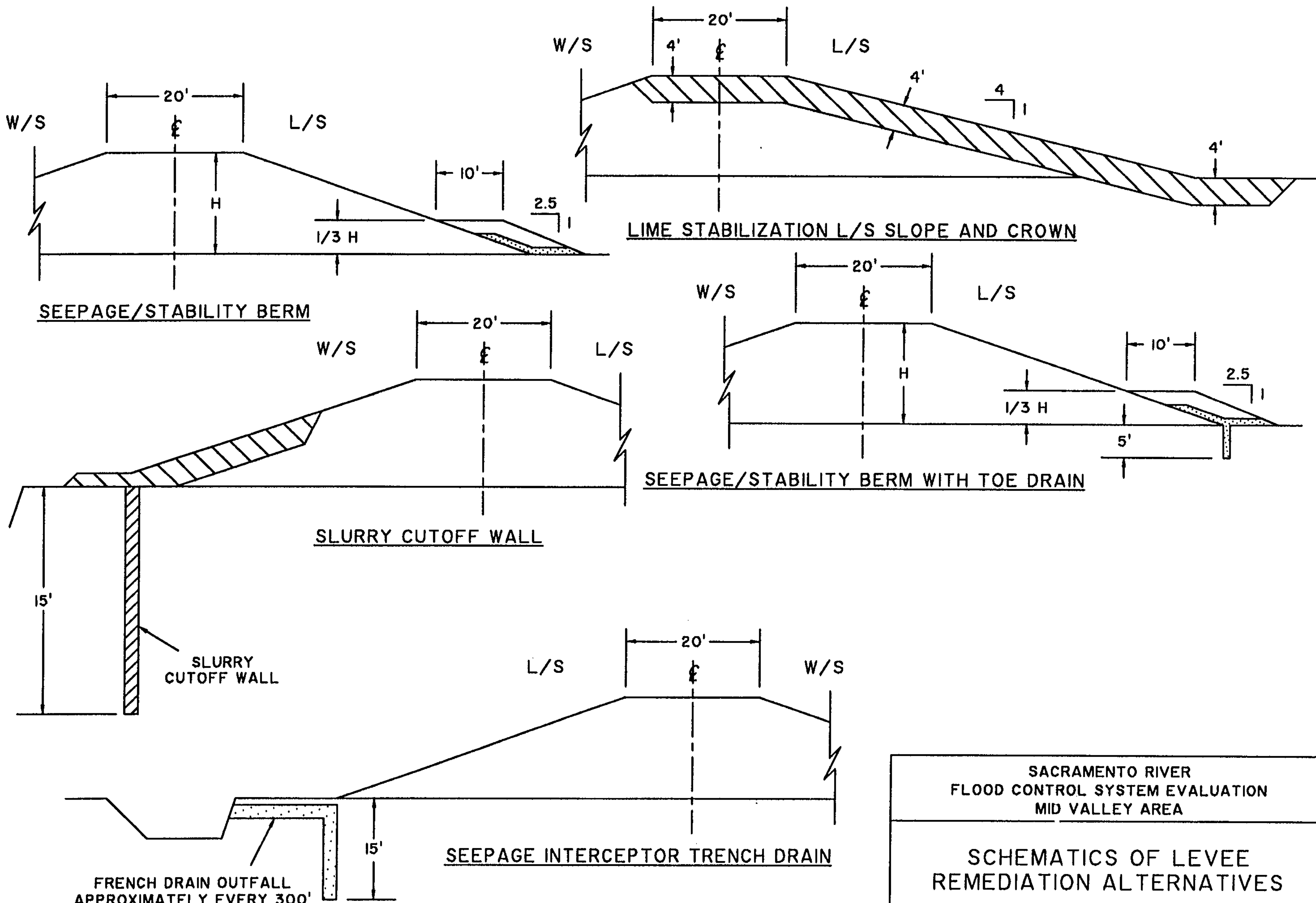
1. REFER TO FIGURE 8 FOR NOTES AND LEGEND.
2. SECTION FROM STA 317+80 (REF. 4), NEAR CHANNEL MILE 4.0.

SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

LEVEE SECTIONS
SACRAMENTO RIVER WESTSIDE LEVEE DISTRICT
KNIGHTS LANDING
EAST BANK LEVEE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 32



SACRAMENTO RIVER
FLOOD CONTROL SYSTEM EVALUATION
MID VALLEY AREA

SCHEMATICS OF LEVEE
REMEDIATION ALTERNATIVES

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

FIGURE 33

APPENDIX D

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

May 23, 1995

Environmental Resources Branch

TO ALL INTERESTED PARTIES:

Enclosed for your review and comment is the draft EA/IS (environmental assessment/initial study) for the Sacramento River Flood Control System Evaluation (SRFCSE) Phase III, Mid-Valley Area. The project consists of reconstructing 18.27 miles of levee on the Sacramento and Feather Rivers, Sutter and Yolo Bypasses, and Knight's Landing Ridge Cut to restore the original design level of flood protection provided by Sacramento River Flood Control Project levees.

In 1992, a Programmatic Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) was completed for the SRFCSE Phases II-V. The Corps of Engineers signed the Record of Decision for the project on November 1992. The Reclamation Board of the State of California is the non-Federal sponsor and State Lead Agency for the project and certified the EIS/EIR as final in March 1993.

The enclosed draft EA/IS reports on the effects that the reconstruction work proposed in Phase III of the SRFCSE would have on resources within the project area. The draft EA/IS discusses the impacts that alternative and recommended reconstruction designs would have on the resources within the project area and proposes necessary mitigation measures.

The EA portion of the document was prepared by the Corps in accordance with the National Environmental Policy Act and includes a finding of no significant impact. The Reclamation Board has prepared a Negative Declaration for Phase III of this project. The Negative Declaration, EA/IS, and the 1992 Programmatic EIS/EIR constitute the environmental documentation required to comply with the California Environmental Quality Act.

Questions and comments on the draft EA/IS should be sent by July 1, 1995, to Ms. Deborah Giglio, U.S. Army Corps of Engineers, Environmental Planning Section (CESPK-PD-R), 1325 J Street, Sacramento, California 95814-2922. Ms. Giglio can also be contacted by phone at (916) 557-5195 or FAX at (916) 557-7856.

The Reclamation Board will consider approval of the Mid-Valley project and the EA/IS at its regularly scheduled meeting on July 21, 1995. The meeting will be held at 10:00 a.m. in the Resources Building Auditorium, 1416 Ninth Street, first floor, Sacramento. Oral comments on this project may be made at that time.

Susan Ramos for
Walter Yep
Chief, Planning Division
Corps of Engineers

Raymond E. Barsch
General Manager
The Reclamation Board

Enclosure

PROPOSED NEGATIVE DECLARATION
SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION
PHASE III - MID-VALLEY AREA

The Reclamation Board of the State of California is acting as Lead Agency under the California Environmental Quality Act for Phase III of the Sacramento River Flood Control System Evaluation. The Board and the U.S. Army Corps of Engineers, the federal sponsor, have previously prepared a Programmatic Environmental Impact Statement/ Environmental Impact Report for Phases II - V of the Sacramento River Flood Control System Evaluation, and now a joint Environmental Assessment/ Initial Study specifically for Phase III of this project. This Negative Declaration has been prepared pursuant to Title 14, Sections 15070, 15071, 15073, and 15222 of the California Code of Regulations. The Corps will be issuing a Finding of No Significant Impact.

PROJECT DESCRIPTION

The Phase III, Mid-Valley project area is located within the Central Valley of California and lies primarily to the north and west of the City of Sacramento. Project areas include portions of the Sacramento River (River Mile 79 to 118), Feather River (River Mile 0 to 3) , Knights Landing Ridge Cut, Sutter Bypass (from Tisdale Bypass to Feather River), and Yolo Bypass (from Fremont weir to Sacramento Bypass).

Levees proposed for repair under this project are a component of the Sacramento River Flood Control Project. After the 1986 flood the Corps initiated a system-wide analysis to determine structural deficiencies within the Project. This analysis and subsequent reconstruction activities were divided into five phases.

The first two phases of the evaluation include the most heavily populated project areas, the Sacramento urban area and the Marysville/Yuba City area. Phase III is the Mid-Valley area and the focus of this report. The remaining two phases include the Lower Sacramento River area south of Sacramento, and the upper Sacramento River area north of Knights Landing.

This project includes reconstruction measures necessary to restore the levees to their design level of flood protection as authorized by Congress in the Flood Control Act of 1917. The reconstruction plan was developed such that the original design level of flood protection provided by Project levees will be restored, but not increased, so that the levees can safely convey the design floodflows at

the design water surface. Alternatives developed and proposed for this project include a seepage stability berm, a seepage stability berm with toe drain, levee crown restoration, a slurry trench cutoff wall, lime treatment, relocation of drainage ditches, and a seepage interceptor trench drain.

PROJECT IMPACTS

The EA/IS reports on the effects that levee reconstruction measures proposed in Phase III of the Sacramento River Flood Control System Evaluation would have on resources within the project area. The report describes the project and project area, discusses impacts of the project on the project area, and recommends mitigation measures to minimize unavoidable resource losses caused by project construction. Alternatives being considered for levee reconstruction would generally consist of work on the crown or landward side of the levees, thus avoiding impacts to waterside riparian habitats.

The following impacts of the project have been identified.

Soils

One of the proposed project repair alternatives for the Mid-Valley project is the application and incorporation of dry lime to levee soils. The specific intent of this application is to change the soil structure and composition. Lime is an alkaline material and can change and increase soil and water pH. This could affect plant species composition in the treated areas. Lime is very light and must be blended and incorporated in a relatively dry condition. This could create large quantities of soil and lime dust during project activities. Stockpiles of lime material are susceptible to wind dispersion and could be sources of runoff contamination.

Where lime treatment is proposed as a construction alternative, the contractor would be required to implement specific mitigation requirements to avoid or reduce the potential for nonintentional changes to the project environment. Examples for mitigation include: stockpiled lime material will be stored only on an impervious surface and will be covered to prevent nonintentional offsite movement.

Based on the information in the record and summarized above and the mitigation measures identified, the Board finds that the project will not have a significant impact on soils.

Air Quality

Temporary impacts to air quality would result from this project. Direct construction impacts on air quality would include dust and particulate generation from earthwork activities, combustion emissions resulting from heavy equipment operation, and airborne slurry particles from the cutoff wall construction alternative. Machinery is likely to cause combustion emissions such as nitrous oxide (NO_x), carbon monoxide (CO) and ozone. Incorporation of dry lime into levee soils, as proposed in the lime treatment alternative, could also generate dust and impact local air quality. This short-term increase in particulates and emissions is considered a short-term unavoidable impact.

To reduce or avoid these impacts, construction vehicles will be fitted with emission reduction equipment as required by State law. Water trucks will be used as necessary to reduce dust and particulate generation at construction sites and along nonpaved roads. Because of the rural nature of the project area, the relatively short duration, and that normal farming activities in the area generate comparable levels of dust, this impact is not expected to be significant.

Based on the information in the record and summarized above and the mitigation measures identified, the Board finds that the project will not have a significant impact on air quality.

Water Quality

One of the proposed project repair alternatives for the Mid-Valley project is the application and incorporation of dry lime to levee soils. Lime is an alkaline material and can change and increase water pH. Lime is a very light material. Stockpiles of lime material are susceptible to wind dispersion and could be sources of runoff contamination. Where lime treatment is proposed as a construction alternative, the contractor would be required to implement specific construction practices to prevent lime contamination of water resources in the project area, including local drainage ditches. Stockpiled lime material will be stored only on an impervious surface and will be covered to prevent nonintentional offsite movement.

Based on the information in the record and summarized above and the mitigation measures identified, the Board finds that the project will not have a significant impact on water quality.

Vegetation and Wildlife

Project construction would adversely affect vegetation at 30 work sites. The loss of habitat acreage and value associated with construction of the project would reduce the carrying capacity of the affected reaches. A total of 224.28 acres would be disturbed. Vegetative cover types that would be adversely affected by the project would include 8.24 acres of riparian woodland, 3.22 acres of scrub-shrub, 13.08 acres of emergent marsh, 0.05 acres of permanent wetland, and 199.69 acres of grassland/agriculture, which consists primarily of levee slope areas and construction easements.

Impacts to grasses on levee slopes and adjacent agricultural lands would be temporary. These areas will be reseeded with a mix of native grasses upon completion of construction. The lime treatment construction alternative would render the top 4 feet of treated soil incapable of supporting vegetative growth because of high pH. In these areas, 12 to 15 inches of topsoil will be placed over the treated soil. A fertilizer would also be added and incorporated prior to seeding to aid in reestablishment of vegetation in these areas.

Within the grassland/agriculture cover type, a maximum of 73 individual trees and shrubs would be removed. Since these individual trees are widely scattered along the 18.27 miles of project area, they were counted by reach and not included as a specific cover type.

Mitigation for the unavoidable loss of habitat values associated with scrub-shrub, wetland, emergent marsh, and riparian vegetation would be provided by reestablishing native vegetation at a suitable mitigation site to replace habitat for wildlife in the affected area. The U.S. Fish and Wildlife Service has determined that 29.66 acres of mitigation is needed to compensate for project impacts. In addition, 365 trees would need to be planted, and 199.69 acres of grassland would need to be reseeded. This 29.66 acres does not include impacts to emergent marsh which would be mitigated for onsite.

Based on the information in the record and summarized above and the mitigation measures identified, the Board finds that the project will not have a significant impact on vegetation and wildlife.

Threatened and Endangered Species

Project construction could potentially impact the valley elderberry longhorn beetle (federal threatened), giant garter snake (federal and State threatened), Swainson's hawk (State threatened), and bank swallow (State threatened). Preproject surveys will be conducted for these species to determine or verify their presence within the project area.

The project would result in potential impacts to elderberry shrubs at several project locations. Elderberry shrubs will be flagged prior to construction and avoided where possible. If preproject surveys determine that this species will be impacted by project activities, USFWS will be consulted. The loss of VELB habitat would be mitigated by replacing impacted elderberry shrubs in general accordance with USFWS guidelines.

The giant garter snake may be affected by project construction through the loss of potential habitat or direct harm to individuals of this species which may be located within the construction area. Since the giant garter snake is a federal and State threatened species, formal consultation would be pursued between USFWS and the Corps (federal) and the Department of Fish and Game and the Board (State) relative to impacts on the giant garter snake if preproject surveys indicate the presence of this species. USFWS and DFG guidelines will be followed relative to avoidance and mitigation for this species, including scheduling construction between May 1 and October 1 in areas where the snake may be present and the construction of the new ditch, including flood up prior to dewatering and filling the old ditch.

The project could affect the State-listed Swainson's hawk. Suitable nesting and foraging habitat are abundant within the vicinity of the proposed project. DFG generally identifies the area within one-half mile of a Swainson's hawk nest site as a sensitivity zone. If no nests or Swainson's hawk territories are found within one-half mile of the project area, then construction can proceed during their nesting season. To avoid affecting Swainson's hawks, construction activities will be scheduled outside of the breeding and nesting season to the greatest extent possible, which is generally March 1 to August 15. If construction activities are necessary within that time frame, then mitigation measures developed in cooperation with DFG will be implemented to ensure protection of this species.

Nesting bank swallows could be affected by this project. Where waterside work is proposed or where suitable nesting habitat is immediately adjacent to the construction area, preproject surveys will be conducted to determine if this species is present. If this species is present, DFG will be consulted and construction deferred at that site until nesting activities for this species are complete.

Based on the information in the record and summarized above and the mitigation measures identified, the Board finds that the project will not have a significant impact on threatened or endangered species.

Cultural Resources

Two cultural resource sites have been located within the project area. Site CA-Sut-11 lies within project Site 19 on the Feather River. This is a mound site which could be significant to Sacramento archeology. There is a high degree of probability that Site CA-Sut-11 would be determined eligible for listing on the National Register of Historic Places. A limiting factor in this regard could be site integrity in view of the fact that the site is farmed and has experienced extensive and severe site disturbance since 1934. Evaluation would be necessary to determine the need for mitigative measures for this site. Project-related construction at this location includes creation of a seepage/ stability berm on the landside of the existing levee. Potential disturbance to the archeological site could result from the movement of heavy equipment across the site. Placement of material on top of the archeological site to create the landside berm would protect the resource.

Site AC-S-2 lies within project Site 12A on the Knights Landing Ridge Cut. This site is described as a surface distribution of farming and ranching equipment and domestic debris dating to the first half of the 20th century. Site AC-S-2 is probably not eligible for listing on the National Register. Project-related construction at this location includes lime stabilization of the landside slope and crown. Construction at Site 12A would require excavation over a portion of the site to a depth of approximately 1 foot, which could disturb cultural material, however this impact is not expected to be significant.

For sites evaluated and determined eligible for listing on the National Register, avoidance is the preferred treatment. If avoidance is not feasible, mitigation would be developed based on the quality of the site and the level of disturbance. Potential impacts to Site CA-Sut-11 appear to be only slight to moderate; the degree and extent of mitigation measures would be determined accordingly. Prior to construction, the project site will be evaluated further. Test borings will be made in an attempt to identify the boundaries of the archeological site. At the time of construction, either a Native American representative or a trained archeologist will monitor the site during earth moving activities in case additional artifacts are uncovered during construction activities.

In the event that human skeletal remains of Native American origin are discovered during construction activities, the statutory requirements set forth in the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) would be adhered to.

Based on the information in the record and summarized above and the mitigation measures identified, the Board finds that the project will not have a significant impact on cultural resources.

Recreation

Any potential effects on esthetic values or recreational opportunities would be short term and not significant. Construction would remove very little, if any, vegetation. Since there is no work in the Sacramento River, water-related recreational activities would not be affected.

Based on the information in the record and summarized above and the mitigation measures identified, the Board finds that the project will not have a significant impact on recreation.

Hazardous, Toxic and Radiological Waste

Lime materials used for the lime treatment alternative demonstrate hazardous waste characteristics due to a pH of 12.5. This is sufficiently high to be potentially harmful to humans, vegetation, wildlife, and aquatic organisms. Lime also has the potential to react dangerously with other hazardous materials. Pure lime is a skin and respiratory irritant. Construction workers will be required to wear appropriate protective equipment to avoid lime dust inhalation and skin contact. Stockpiled lime material will be stored only on an impervious surface and will be covered to prevent nonintentional offsite movement.

Based on the information in the record and summarized above and the mitigation measures identified, the Board finds that the project will not result in the generation of hazardous, toxic or radiologic waste.

MANDATORY FINDINGS

Based on the information in the record, the Board, in its independent judgement, finds:

- The project does not have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal, or eliminate important examples of the major periods of California history or prehistory.

- The project does not have the potential to achieve short-term, to the disadvantage of long-term, environmental goals.

- The project does not have impacts which are individually limited, but cumulatively considerable.

- The project does not have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly.

ADMINISTRATIVE RECORD

The documents upon which these findings and conclusions are made are available for inspection by contacting Marge Nagel at 1020 Ninth Street, Room 240, Sacramento, California, 95814, or telephone (916) 327-1541.

DETERMINATION

The Board finds that although the proposed project could potentially have significant effects on the environment, there will not be a significant effect because of the mitigation measures described above and in the record.

MAY 3 1 1995

Date

Raymond E. Barsch
General Manager
The Reclamation Board

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION
Phase III – Mid-Valley Area

DRAFT ENVIRONMENTAL ASSESSMENT/ INITIAL STUDY

May 1995

US Army Corps of Engineers

Sacramento District

The Reclamation Board

State of California

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

May 26, 1995

Environmental Resources Branch

FINDING OF NO SIGNIFICANT IMPACT
Sacramento River Flood Control System Evaluation, Phase III
Mid-Valley Area, Sacramento, California

1. I have reviewed and evaluated information presented in this environmental assessment (EA) prepared for the Sacramento River Flood Control System Evaluation, Phase III, Mid-Valley Area and considered the views of other interested agencies, organizations, and individuals concerning the reconstruction work in the Mid-Valley Area.

2. The possible consequences of conducting the work described in the EA have been studied with consideration given to environmental, socioeconomic, cultural, and engineering feasibility. The impacts and mitigation requirements have been thoroughly coordinated with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, the California Department of Fish and Game (DFG), and The State Reclamation Board. Measures recommended by DFG have been incorporated to avoid effects on the State-protected Swainson's hawk. Mitigation is being provided to offset impacts to critical riparian forest and emergent marsh habitat for the giant garter snake. In addition, mitigation would also be provided for the threatened valley elderberry longhorn beetle if adversely affected.

3. Based on my review, I have determined that the proposed reconstruction work would result in no significant effects on the environmental and cultural resources and that the mitigation measures are sufficient to lessen the potential effects on riparian and emergent marsh habitats, in addition to elderberry bushes that provide habitat for the Valley elderberry longhorn beetle.

4. Based on these considerations, I am convinced that there is no need to prepare an environmental impact statement. Therefore, an EA and finding of no significant impact provide adequate environmental documentation for the proposed action.

_____________________ Date

* _____________________
John N. Reese
Colonel, Corps of Engineers
District Engineer

* To be signed, if appropriate, after the public review period.

Draft Environmental Assessment/Initial Study

Sacramento River Flood Control System Evaluation
Phase III, Mid-Valley Area

Table of Contents

Tables

Plates

Appendixes

Environmental Assessment/Initial Study
Sacramento River Flood Control System Evaluation
Phase III, Mid-Valley Area

Introduction

The Sacramento District of the Corps of Engineers prepared an Initial Appraisal Report in December 1991 for reconstruction of the levees of the Sacramento River Flood Control System in the Mid-Valley area, which includes portions of the Sacramento and Feather Rivers, as well as portions of Knights Landing Ridge Cut and Yolo and Sutter Bypasses. This document evaluates and describes the reconstruction measures necessary to restore the levees to their design level of flood protection as authorized by Congress in the Flood Control Act of 1917. The reconstruction plan was developed such that the original design level of flood protection provided by project levees will be restored, but not increased, so that the levees can safely convey the design floodflows at the design water surface. The design of the existing levee embankments of the system were based on (1) a design discharge or channel capacity, (2) a design water surface profile, and (3) a minimum freeboard requirement above the design water surface profile.

This Environmental Assessment/Initial Study (EA/IS) is a combination document that has been prepared in accordance with the National Environmental Quality Act (NEPA) and California Environmental Quality Act (CEQA) guidelines. This EA/IS is being prepared jointly by the Corps as Federal sponsor and the Reclamation Board of The State of California (Board) as State Lead Agency and non-federal sponsor. This document reports on the effects that levee reconstruction measures proposed in Phase III of the Sacramento River Flood Control System Evaluation would have on resources within the project area. The report describes the project and project area, discusses impacts of the project on the project area, and recommends mitigation measures to minimize unavoidable resource losses caused by project construction. This document fulfills the NEPA regulations formulated by the Council on Environmental Quality (40CFR 1500-1508) including those required by the Fish and Wildlife Coordination Act, the National Historic Preservation Act, and the Endangered Species Act (40CFR 1502.25). The NEPA regulations also encourage Federal agencies to prepare NEPA documents in cooperation with State requirements to reduce duplication of effort. CEQA (Fish and Game Code Section 2090 et Seq.) requires formal consultation between the Department of Fish and Game (DFG) and a State lead agency when a proposed action subject to CEQA may affect a state endangered, threatened or candidate species.

This levee reconstruction project is being done under Phase III of the Sacramento River Flood Control System Evaluation. The purposes of this evaluation are (1) to evaluate the integrity and level of flood protection provided by the existing Sacramento River Flood Control Project levees, (2) to determine whether the levees currently function as designed, and (3) if reconstruction is needed, to determine the Federal interest in proceeding with construction. Due to the size and complexity of the total project area, the study has been divided into five phases **(Plate 1)**. The levees in the Sacramento Urban Area were evaluated in the first phase. Phase II included the Marysville/Yuba City Area Levee Reconstruction Project. Phase III, the Mid-Valley area, includes portions of the Knights Landing Ridge Cut, Yolo and Sutter Bypasses, and levees on the Feather and Bear Rivers not considered in the Phase II report, as well as project levees on Yankee Slough and Dry Creek. **Plate 2** shows a general map of the Mid-Valley area.

The first two phases of the evaluation included the most heavily populated project areas, the Sacramento urban area and the Marysville/Yuba City area. The investigations for the first two phases resulted in Initial Appraisal Reports in May 1988 and January 1990. The EA/IS was prepared for the first phase, and the Finding of No Significant Impact (FONSI)/Negative Declaration was signed on July 9, 1990. Construction on Phase I is complete. The plans and specifications are currently being developed for restoration to the Old Sacramento floodwall as an additional component to Phase I. A Programmatic Environmental Impact Statement/ Environmental Impact Report (EIS/EIR), a generalized document for Phases II-V, was completed in June 1992. In accordance with the EIS/EIR, a site-specific EA/IS was prepared for the second phase, and the FONSI/Negative Declaration was signed on April 29, 1993. The plans and specifications for Phase II are currently being developed.

In the remaining two phases, areas to be evaluated include (1) the Lower Sacramento area (Delta), including project levees south of West Sacramento and south of Sacramento (Phase IV); and (2) the Upper Valley area from Knights Landing on the Sacramento River north, including tributaries such as Elder and Butte Creeks (Phase V).

Study Purpose and Scope

This EA/IS reports on the effects that the reconstruction work proposed in Phase III of the Sacramento River Flood Control System Evaluation would have on resources within the project area. The purpose of this EA/IS is to describe the project features and project area, evaluate the impacts of the project on resources in the project area, and recommend

mitigation measures to minimize unavoidable resource losses caused by project construction.

This EA/IS has been prepared to evaluate the impacts that alternative and recommended designs would have on the resources within the project area and to develop mitigation, as necessary. The alternatives and locations where each construction method might be used are described in the Proposed Action and Alternatives section.

Need for Action

The Sacramento River Flood Control System Evaluation for the Mid-Valley area includes 200 miles of levees along portions of the Feather and Sacramento Rivers and their tributaries. The project area also includes portions of the Sutter and Yolo Bypasses and Knights Landing Ridge Cut. Past studies have shown that sections of the project levees are susceptible to seepage and stability problems and do not provide the design levels of flood protection. Of the 200 miles of levees studied, 18.27 miles are in need of reconstruction and/or levee raising to meet the "Levee and Channel Profiles, Sacramento River Flood Control Project," dated March 15, 1957.

The study area covers portions of five counties: Placer (population 147,200), Solano (312,800), Sutter (62,600), Yolo (133,000), and Yuba (57,300); population statistics are estimates from the Rand McNally 1990 Commercial Atlas and Marketing Guide. Davis and Woodland, two of the largest cities within the study area, have populations of 52,237 and 36,500, respectively. Smaller communities include East Nicolaus (225), Nicolaus (100), and Robbins (400) in Sutter County, as well as rural communities such as Karnak, Kirkville, and Verona, for which no population statistics are available. In Yolo County, Knights Landing has a population of 846 and Yolo 650. Wheatland, in Yuba County, has a population of 1,474. (Population statistics for the cities are from the California Department of Finance, Population of California Cities, January 1989.) Between 2,000 and 3,000 people live within the flood hazard areas. Public and private property (including contents) within the flood hazard areas are valued at $170 million.

Most of the developed lands in the Mid-Valley area are protected by more than one levee. The community of Knights Landing is surrounded by levee on the Sacramento River, Yolo Bypass, Colusa Basin Drainage Canal, and Knights Landing Ridge Cut. The community of Robbins is protected by levees on the Tisdale Bypass, Sutter Bypass, and Sacramento River. Similar conditions exist within other areas of the study area. Depths of flooding resulting from levee failure could range up to a

maximum of 20 feet for major flood events. Because of the susceptibility of levee embankments and foundation soils to piping and seepage, levee breaks can and have occurred unexpectedly and with little or no warning time. In addition, levee breaks can and have occurred with significant freeboard still remaining on the levee embankments.

Historic levee failures have resulted in significant property damage and loss of human life. In December 1955, the east levee of the Feather River about 1 mile downstream of Nicolaus failed, and about 24,600 acres were flooded in Reclamation District (R.D.) 1001. The towns of Nicolaus and East Nicolaus were partially flooded. Two people reportedly lost their lives as a direct result of the flooding, and about 1,000 people had to be evacuated from the area. In February 1986, the north levee embankment on Yankee Slough in Sutter County failed. Houses, farm structures, and about 700 acres of peach and walnut orchards were flooded to a depth of 3 or more feet.

Population at Risk

A major adverse impact resulting from a levee failure within the study area is the potential for loss of human life. The extent of the impact would depend on the location and magnitude of flooding, time of day, warning time, flood fight efforts, and effective implementation of a flood evacuation plan. A preliminary assessment was made of potential loss of life should a levee failure occur during a major flood event. The assessment assumed the existence of a local evacuation plan and a flood warning system. The order to evacuate would probably occur 1 to 2 hours before a levee break. Because of the short warning period, only a small percent of the people residing in a potential flooded area, probably between 10 and 20 percent, would be able (or choose) to evacuate in a timely manner. Because of the potential for deep depths of flooding, a levee failure in the vicinity of populated areas would probably result in loss of life, probably between 5 and 10 people.

Flood warnings are generally based on existing and projected flood stages in a specified levee reach. Normally, critical flood stages would be those that are at or near the design water surface (about 3 to 6 feet below the levee crown). Because of the potential modes of levee failure, instability, and piping, levee failures can and have occurred in and adjacent to the study area at flood stages that are 5 to 10 feet below the top of levee. In addition, levee failures can and have been rapid blowouts of levee embankment materials at the landside toe of the levee. A reasonable flood warning and evacuation plan would be difficult to develop and enforce. As a result, loss of human life is

expected under existing conditions (without reconstruction work) for major flood events. Because public safety is a primary concern, there is potential justification for Federal and State interests in reconstruction work proposed in this study.

Historic Flooding

The study area has experienced frequent floods in the past, many before streamflow data were recorded. Prior to completion of Oroville Dam, large floods caused levee failures and resulted in severe damages to lands in the flood plain **(Plate 3)**. In addition, devastating floods in 1950, 1955, and 1964 caused loss of life and property damage in the study area.

The flood of 1955 was the most widespread and destructive of any in the recorded history of northern California since the legendary floods of the 1800's. On December 23, 1955, the east levee of Feather River about 1 mile downstream from Nicolaus failed, and about 24,600 acres were flooded in R.D. 1001. The towns of Nicolaus and East Nicolaus were partially flooded. Two people reportedly lost their lives as a direct result of the flooding, and about 1,000 people had to be evacuated from the area. In addition, the west levee of the Western Pacific Intercept Canal was breached in three places. Two breaches in the north levee of Yankee Slough resulted in flooding to several hundred acres of highly developed orchard land, also in R.D. 1001. In all, 37,000 acres of highly productive farm and ranch lands were inundated, and large numbers of livestock drowned. Roads, railroads, and bridges, and public, commercial, and industrial properties were also flooded and damaged. Flood damage in the area downstream from Marysville was estimated at more than $34 million.

In 1958, high flows on the Sacramento River caused flooding in the Sutter and Yolo Bypasses. For more than 2 months, about 57,000 acres were flooded to depths estimated at 6 to 12 feet. The main agricultural damages were loss of crops, costs of releveling land, repair of farm roads, costs of repair and replacement of fences, repair of pumps and other irrigation facilities, repair of private levees, and the costs of removing debris.

The storm of December 1964 had the greatest flood-producing potential of any storm on record at that time. Widespread damages were primarily in areas not protected by project works. Sutter and Yolo Bypasses were flooded. Downstream levees on Feather River and tributary levees on Bear and Yuba Rivers confined the floodflows and limited damages to the cost of repairing the levees and the loss of

various improvements within the levees. On the Bear River system, flood damage occurred along Yankee Slough and on the streams tributary to the Western Pacific Intercept Canal.

Floods of 1982-83

The winter of 1982-83 has been described as California's wettest winter in more than a century and resulted in a disastrous year of flooding. Of California's 58 counties, 45 were declared national disaster areas, including the five in the Mid-Valley study area (Placer, Solano, Sutter, Yolo, and Yuba).

In Yolo County, a major storm during the latter part of January 1983 brought flood stages to Cache Creek. Early on the morning of January 24, the south levee of Cache Creek, a Sacramento River Flood Control Project levee, failed about 2 miles east of Woodland, north of Highway 5. Following the break, twelve flood fighters were stranded for a few hours between the break site and the stub end of the levee system before rescue by a California Highway Patrol helicopter. About 600 acres of farmland were flooded as a result of the levee break, and another 30 acres were inundated when a hole was punched into the north levee to relieve pressure on gradually deteriorating levees. Upstream from the break, local emergency officials, volunteers, and Department of Water Resources (DWR) crews formed a protective sandbag barrier around portions of the town of Yolo.

The town of Knights Landing was threatened when water backed up in the Knights Landing Ridge Cut (a bypass channel parallel to the Sacramento River from Knights Landing to the Yolo Bypass). Volunteers constructed sandbag barriers which were successful in keeping water out of the town. Nevertheless, overflowing local sloughs caused several homes in the Knights Landing area to be flooded.

With the continuing high runoff, several portions of the Yolo Bypass levees began to slip, including a 500-foot section on the east levee upstream from Highway 80. The Corps constructed a landside berm along the damaged section to prevent further slippage.

In Sutter County, thousands of acres of fruit trees were inundated during the 16 days of March rain. Near Robbins, a landside section of levee slipped vertically 2 feet, and prompt action by reclamation district officials and State flood fighters prevented its loss. The slippage site and other vulnerable sites were monitored for several weeks.

Floods of February 1986

Major storms in February 1986 resulted in floods of record for many parts of northern and central California. Record flow releases from reservoirs affected downstream levee systems, eroded levee embankments, and exceeded flood control project design levels.

At 8:00 a.m. on February 22, levee patrols of Sutter County's R.D. 1500 discovered a 500-foot-long slump, up to 4 feet deep, on the west levee of the Sutter Bypass near Robbins. High flows in the bypass had caused boils and extensive piping damage. The Robbins fire chief ordered the community of nearly 400 residents evacuated at 8:15 a.m., and evacuation was completed within an hour. Emergency flood fight efforts by the Corps reinforced the sagging levee and probably prevented a levee break. Cost of the flood fight was about $290,000. Complete levee failure was averted, but extensive damages resulted, including slumping of the levee crown, landside slope cracking, and large holes at the landside levee toe.

Damage to the levee was the result of piping due to the sustained high water and the presence of nearly continuous layers of highly pervious and erodible sands and silts within the levee embankment and foundation.

Authorization

The Sacramento River Flood Control Project was originally authorized by the Flood Control Act of 1917. The present evaluation of the Sacramento River Flood Control System was authorized by the Conference Report accompanying the Energy and Water Development Appropriation Act, 1987 (Public Law 99-591), which included funds under Operation and Maintenance, General Appropriation, Inspection of Completed Works for evaluation of the flood control system for the Sacramento River and its tributaries. Both the House of Representatives and Senate versions of the Conference Report contain similar language.

The House of Representatives Report, 99-670, is quoted as follows:

> Inspection of Completed Works: Sacramento River Flood Control Project, California. -- The Committee has included $600,000 for a comprehensive analysis of the long-term integrity of the flood control system for the Sacramento River and its tributaries in collaboration with the State of California. The Committee is aware that even before the recent flooding, regional flood

control officials felt the need for a thorough survey of the system. While it did serve well in the floods and prevented billions of dollars in damages, under stress it validated concerns that in many places remedial work is necessary as soon as possible, as may be enhanced levels of protection. The Corps is directed to report back to the Committee on protection enhancement requirements which it encounters in the review of the project.

The Senate's Report, 99-441, states the following:

Inspection of Completed Works, Sacramento River Flood Control Project, California. -- The Committee is aware of the need for a comprehensive analysis of the integrity of the flood control system for the Sacramento River and its tributaries. Given the importance of this flood protection system, the Committee believes that such an analysis is warranted.

Project Location

The Mid-Valley study area is located within the Central Valley of California and lies primarily to the north and west of the Sacramento metropolitan area. Specific levees considered in the initial study for the Mid-Valley area included portions of Western Pacific Intercept Canal, Dry Creek, Yankee Slough, Bear River, Tisdale Bypass, Sutter Bypass, Feather River, Natomas Cross Canal, Coon Creek Group Interceptor, Sacramento River, Knights Landing Ridge Cut, Cache Creek, Willow Slough Bypass, Putah Creek, Sacramento Bypass, and Yolo Bypass. Locations of project levees are shown in **Plate 4**. This EA/IS examines Sites 1-20 proposed for construction improvements located in the following areas:

Sutter Bypass. About 20.8 miles of the west levee from the confluence with Tisdale Bypass downstream to the confluence with the Sacramento River. Levee heights range from 20 to 35 feet above the landside ground surface. Crown widths are from 15 to 20 feet. Ditches are located along both the waterside and landside levee embankment toes.

Feather River. About 12.3 miles of the east levee from the confluence with the Bear River downstream to the confluence of the Feather and Sacramento Rivers. Levee heights range from 15 to 25 feet above the landside ground surface. Crown widths are from 25 to 35 feet.

Sacramento River. About 34.7 miles of the east levee from the confluence with Tisdale Bypass downstream to the confluence with the Natomas Cross Canal and about 24.1 miles of the west levee from the confluence with Knights Landing Ridge Cut (Colusa Basin Drainage Canal) downstream to the

confluence with the Sacramento Bypass. Levee heights range from 12 to 20 feet above the landside ground surface. Crown widths are from 15 to 45 feet.

Knights Landing Ridge Cut. About 6.3 miles of levee along the east bank from the confluence with Yolo Bypass to the upstream project limits. Levee heights range from 10 to 20 feet above the landside ground surface; crown widths range from 10 to 30 feet.

Yolo Bypass. About 12.3 miles of the east levee from the confluence with the Sacramento River downstream to the confluence with the Sacramento Bypass and about 15.4 miles of the west levee from the confluence with the Sacramento River downstream to the confluence with Putah Creek (excluding that segment of levee bordering the Cache Creek Settling Basin). Levee heights range from 15 to 25 feet above the landside ground surface. Crown widths are from 15 to 35 feet.

Scope of Analysis

This EA/IS describes the environmental conditions and the effects of levee reconstruction at selected sites. The proposed reconstruction sites, staging and borrow sites are shown in **Plate 5** and described below. The EA/IS describes the final project design, construction impacts, and mitigation provided for those impacts. This EA/IS is being circulated for full public review and comment. To define the impacts of this project, the U.S. Fish and Wildlife Service (FWS) prepared a Habitat Evaluation Procedure (HEP) analysis. Based on its findings, FWS also prepared a Coordination Act Report (CAR) that discusses pre-project conditions, project impacts, and mitigation for project impacts. The HEP study and CAR are included in Appendix A of this EA/IS.

Proposed Action and Alternatives

Technical studies indicate potential levee embankment problems and freeboard deficiencies. Alternatives developed address these inadequacies. With the exception of one construction alternative, cutoff wall at waterside levee toe, and the no-action alternative, alternatives being considered for levee reconstruction would generally consist of work on the crown or landward side of the levees, thus minimizing impacts to riverside riparian habitats. Cross-sections of design alternatives are shown in **Plates 6 and 7.** The types and locations of each construction method are described below.

No Action Alternative

No action. No levee reconstruction would occur with the no action alternative and the levees would remain in their

current condition. This alternative would likely result in levee failure for flood events of lesser magnitude than specified for design conditions, economic damages, and possible loss of life. The overall extent of damages would depend on several factors, including magnitude and duration of flooding, and the success of emergency flood fighting efforts. Significant costs could be incurred for reconstruction of structures damaged by floods (FWS, 1995).

Construction Alternatives

Seepage stability berm. This alternative would consist of constructing drainage improvements and berms at the landside toe of the existing levee embankment. A drainage blanket would be placed along the lower landside slope and extend landward of the landside toe with a stability earth berm constructed over the drainage blanket. Direct construction impacts would consist of removing vegetation (clearing and grubbing) along the landside toe to as much as 60 feet beyond the toe as well as about 10 feet up the lower landside levee slope. Generally, there would be no berms constructed where ramps or raised areas around existing structures are located. The seepage stability berm/toe drain alternative described below is a variation of the seepage stability berm alternative. Both designs have the same surface impacts to vegetation. The stability berms would counteract hydraulic seepage pressure within the levees during high flows, thus improving levee stability at the landside levee toe.

Seepage stability berm/toe drain. This alternative would consist of constructing drainage improvements and/or stability berms at the landward toe of the existing levee embankment. Toe drains would be constructed about 1 foot wide and 5 feet deep adjacent to the levee toe. A pipe would be placed at the bottom of the toe drain, and the excavated area filled with imported coarse material. A seepage/stability berm on the lower landside levee slope and adjacent toe area would be constructed as described in the above alternative. The toe drains would intercept and convey seepage waters away from the toe of the levee. The stability berms would counteract hydraulic seepage pressure within the levees during high flows, thus improving levee stability at the landside levee toe.

Levee crown restoration. This alternative would consist of restoring levee crown elevation to the design freeboard above the design water surface. Site impacts would consist of removing vegetation (clearing and grubbing) on the top of the levee crown, and possibly 1 to 2 feet on the waterside and landside slopes where fill material may be placed to meet the existing slope.

Constructing slurry trench cut-off walls. This alternative would consist of digging a trench down the middle of the levee or along the waterside toe and filling it with cement, bentonite, and other material, thus improving structural stability. The impervious material significantly reduces the movement of water through the levee, prevents piping of the levee or foundation material, and prevents landside levee boils during floods. To function successfully, the cutoff wall must be keyed into a relatively impervious clay or silt foundation.

Remediation using slurry cutoff wall through the levee crown is most appropriate in places where development is close to the levee toe (within 75 feet). A 3-foot-wide trench would be dug in the center of the levee crown or along the waterside toe which would extend into the levee foundation. This trench would then be filled with the appropriate material to minimize seepage through the levee.

Direct construction impacts would consist of removing vegetation (clearing and grubbing) on the levee crown or along the waterside toe and using a trenching machine, backhoe, and other equipment along the waterside toe or on the top of the levee. For the waterside toe slurry wall, the waterside slope would have a bentonite layer applied. A staging area would be used to mix the cement, bentonite, and other materials which would be pumped into the excavated trench. The cutoff wall alternative may require no additional right-of-way. However, traffic on the top of the levee, such as Garden Highway in RD 1001, would have to be rerouted if the cutoff wall was constructed through the levee crown.

Lime treatment. This alternative would consist of removing a 4-foot depth of levee material from the crown and landside slope to about 10 feet beyond the levee toe, stockpiling the material, mixing it with lime (approximately 2 to 4 percent), and recompacting it to an established landside slope. The landside slope would vary from site to site from 2:1 to 4:1. The levee slopes and crown would be reconstructed during the process. Direct construction impacts would consist of generating lime dust, removing vegetation (clearing and grubbing) on the crown and landside slope to about 10 feet beyond the toe, and about the top 5 feet of the waterside slope. Specific measures would be required of the construction contractor to control lime dust. Lime stabilization by injection of lime materials into the interior of the levees may also be considered as a alternative to topical lime treatment.

Filling and/or relocating existing drainage ditches. Direct construction impacts would consist of filling an existing ditch or digging a new ditch. Fill for the existing

ditch may consist of materials excavated from the new ditch. No work would be done on the existing levee slope, except possibly construction of an access ramp if needed. Temporary construction impacts would also occur from trucked and wheeled machinery to move fill or excavate materials.

Seepage interceptor trench drain. This alternative would consist of cutting a 15-foot-deep trench, about 2 feet wide, and filling it with sand. Every 300 feet, a perpendicular French drain or piping would empty into the adjacent irrigation canal. Direct construction impacts would consist of removing vegetation (clearing and grubbing) along the landside toe to about 10 feet beyond the toe, and clearing and grubbing an area about 10 feet wide perpendicular to the levee and extending from the toe to the adjacent irrigation canal.

The proposed repair work would consist of a combination of the above alternatives at work Sites 1-20. **Table 1** presents the repair alternatives which are proposed for each site, and levee miles and acres that would be affected.

Staging, Borrow, and Disposal Areas

Staging and borrow areas for the project are described below. Disposal of excess material at the local county dump would be the responsibility of the contractor. In general, staging areas would be needed for all construction methods. Some staging activities may take place on top of the levees. Staging areas may consist of vehicle and equipment parking, office trailer parking, and material storage. In areas of cutoff wall construction, the staging area may also serve as a batch plant location. Sixteen staging areas are located throughout the project area for easy access to each work site and are identified on Plate 5.

Soil from the borrow area would be used for raising, constructing and restoring the levees. Three borrow sites that could be used include:

Tisdale Bypass. The Reclamation Board owns several hundred acres within the Tisdale Bypass. This area is currently undeveloped and not used for farming or grazing. To ensure the functioning of the bypass, woody growth is routinely removed from the area. In the past large quantities of sediment have been removed from the bypass and stockpiled as overbuilt levees. Approximately 20 acres would be excavated for by this project. Borrow material may be taken from within the bypass or from the overbuilt levees. Established riparian vegetation would not be disturbed by this project.

Fremont Weir. The Reclamation Board owns several hundred acres immediately upstream and downstream of the Fremont Weir. The proposed borrow area is a stockpile of material generated during a previous sediment removal project. The stockpile contains in excess of 200,000 cubic yards of material and is located upstream of the weir in the area known as Rattlesnake Island. Approximately 48 acres would be used. No established riparian vegetation would be excavated by this project.

Cache Creek Settling Basin. The Reclamation Board owns approximately 300 acres in the Cache Creek Settling Basin. The area is between the new east training levee and the old low flow channel, south of the south levee of Cache Creek. The area is currently fallow, but had been previously farmed. Approximately 40 acres would be excavated by this project.

The estimated acreages affected by the proposed project are identified in **(Table 1)**. Acreage for the borrow sites was determined by FWS planimetering the sites outlined on aerial photographs by FWS (FWS, 1995). Actual impacts of borrow sites are expected to be much smaller than the amount identified in this EA/IS. FWS estimates assume the use of construction alternatives that have the maximum impact at each site and would require the most borrow material. Soil excavated from borrow areas would be measured in cubic yards, and actual volumes used for levee reconstruction would be recorded during construction.

Borrow areas would be stripped of surface vegetation and topsoil prior to construction. This material would be stockpiled during construction and spread back onto the borrow site once construction activities are completed. The contractor would be required to protect woody vegetation at all borrow sites and staging areas. Staging areas would be located near each construction site on the landside except Sites 17 and 18 that may require waterside staging areas (located approximately 50 feet from the water) for construction activities. All staging and borrow areas would be reseeded with native grasses when construction is complete.

The contractor would be responsible for disposal of excess construction and excavation materials and would be required to comply with all applicable Federal, State, and local regulations, such as the Clean Water Act and the National Historic Preservation Act.

Table 1. Site locations, proposed remedial repair work alternatives, miles impacted, and acres impacted for the Sacramento River Flood Control System Evaluation, Phase III project.			
SITE #, LOCATION, AND RIVER MILE	PROPOSED REMEDIAL REPAIR WORK	MILES IMPACTED	ACRES IMPACTED
1-Sutter Bypass 17.9-18.6R	Seepage interceptor trench drain	0.70	0.09
2-Sutter Bypass 13.75-14.75R	Seepage interceptor trench drain	1.00	0.12
2-1 Sutter Bypass 4.22R	Seepage interceptor trench drain	0.05	0.01
2-2 Sutter Bypass 4.89R	Seepage interceptor trench drain	0.05	0.01
2-3 Sutter Bypass 7.67R	Seepage interceptor trench drain	0.05	0.01
2-4 Sutter Bypass 9.13R	Seepage interceptor trench drain	0.03	0.01
2-5 Sutter Bypass 9.53-9.60R	Seepage interceptor trench drain	0.06	0.01
2-6 Sutter Bypass 10.32-10.38R	Seepage interceptor trench drain	0.06	0.01
2-7 Sutter Bypass 12.09R	Seepage interceptor trench drain	0.03	0.01
2-8 Sutter Bypass 15.45R	Seepage interceptor trench drain	0.02	0.01
2-9 Sutter Bypass 16.12R	Seepage interceptor trench drain	0.03	0.01
2-10 Sutter Bypass 17.14R	Seepage interceptor trench drain	0.03	0.01
3-Sutter Bypass 2.0-3.0R	Lime treatment, ditch relocation	1.00	14.65
4-Sacramento River 116.2-117.2L	Seepage/stability berm/toe drain	1.00	14.60
5-Sacramento River 109.9-110.5L	Fill seasonal ditch, reshape landside toe	0.60	5.14
6-Sacramento River 104.8-105.7L	Seepage/stability berm/toe drain	0.87	12.67
7-Sacramento River 85.2-85.9L	Seepage/stability berm/toe drain	0.70	10.19
9-Sacramento River 87.1-87.3R	Seepage/stability berm/toe drain	0.20	1.93
10-Sacramento River 86.8-86.9R	Seepage/stability berm/toe drain	0.10	1.38
11-Sacramento River 85.2-85.6R	Seepage/stability berm/toe drain	0.40	5.51
12-Knights Landing Ridge Cut	Lime treatment, ditch relocation, reshape levee	2.17	43.82
12A-Knights Landing Ridge Cut	Lime treatment	0.85	10.33
13-Knights Landing Ridge Cut	Lime treatment, ditch relocation	0.38	6.47
14-Sacramento River 80.8-81.5R	Seepage/stability berm/toe drain	0.70	10.19
15A-Yolo Bypass	Restore levee crown, lime treatment, ditch relocation	1.32	20.25
15B-Yolo Bypass	Restore levee crown, lime treatment	4.82	51.24
17-Feather River 2.2-2.4L	Seepage/stability berm or cutoff wall	0.20	2.57
18-Feather River 0.78-0.93L	Cutoff wall or seepage/stability berm	0.15	2.57
19-Feather River 0.35-0.55L	Seepage/stability berm and fill ditch	0.20	2.75
20-Sacramento River 79.0-79.5L	Seepage/stability berm/toe drain	0.50 18.27	7.71 224.28
Borrow Site 1, near Tisdale Weir Borrow Site 2, near Fremont Weir Borrow Site 3, near Cache Creek Setting Basin			20.00 48.00 40.00 108.00

Source: FWS Draft CAR 1995

Existing Environment

Description of Project Area

The Mid-Valley project area lies primarily to the north and west of the Sacramento Metropolitan area in the Central Valley of California,encompassing portions of Sutter, Yuba, Yolo, Placer, and Solano Counties. The study area includes about 200 miles of the Sacramento River Flood Control Project levees along the Sacramento and Feather Rivers. The study area also includes portions of the Sutter, Tisdale, Sacramento, and Yolo Bypasses; portions of Bear River; Yankee Slough; Dry, east levee of the Knights Landing Ridge Cut; Coon Creek Group Interceptor; Western Pacific Intercept Canal; and the Natomas Cross Canal. Twenty sites are proposed for construction improvements in the Sacramento and Feather Rivers, Sutter and Yolo Bypasses and the Knights Landing Ridge Cut **(Table 1)**.

Climate in this area of the California Central Valley is semi-arid, with warm, dry summers and moderate winters. Rainfall averages about 18 inches annually, generally between November and March.

Agriculture dominates land use in the Mid-Valley Area. Orchard, row crops, and grain are cultivated landward of the project levees. Portions of both the Yolo and Sutter Bypasses are within the Mid-Valley Area. The bypasses convey overflow from the Sacramento River during the flood season and are farmed during the non-flood season. A portion of the Sutter Bypass is also designated as a national wildlife refuge.

The Sacramento River system is the largest watershed in California, draining 26,300 square miles of the Central Valley, the Coast, Cascade, and the Sierra Nevada mountain ranges. A system of levees bounds much of the Sacramento River downstream from the city of Chico to the Delta. Flows are regulated by major dams and reservoirs, such as Shasta on the mainstem of the Sacramento River, and Whiskeytown, Oroville, New Bullards Bar, Folsom, Black Butte, and Berryessa on the Sacramento River tributaries.

Since the construction of these storage facilities, the river has been used to transport water to the Sacramento-San Joaquin Delta and the State and Federal export pump facilities of the State Water Project and Central Valley Project. The sustained high-water level during the summer months, although controlled by upstream developments, contributes to some streambank erosion. The major factor contributing to the erosion of river banks, however, is winter floodflows. The amount of bank erosion from winter floodflows has decreased

due to decreasing annual precipitation and subsequent low flows for the past several years. Two-thousand square miles of fertile agricultural land and about 50 communities are located in the Sacramento River flood plain (FWS 1995).

The Feather River originates in the Sierra Nevada in eastern Plumas County and flows south for 39 miles before flowing into the Sacramento River. Oroville Dam, located near the town of Oroville upstream of the project area, controls flows on the Feather River. The Feather River drains an area of 3,611 square miles above Oroville Dam. Between Oroville and Marysville, the Feather River drains an area of 369 square miles. The river flows south through relatively level and gently rolling terrain for a distance of 39 miles (Yuba County, 1988).

The Sutter Bypass, located between the Sacramento and Feather Rivers, is a system of levees that diverts overflow from the Sacramento River and tributary inflow through agricultural lands east of the Sacramento River. The bypass rejoins the Sacramento River near the Fremont Weir just west of the Natomas Cross Canal where it becomes the Yolo Bypass.

The Yolo Bypass is located immediately west of the metropolitan area of Sacramento and extends from Fremont Weir downstream to Liberty Island, a distance of abut 43 miles. The bypass is bounded by high levees (as high as 20 feet), encompasses about 40,000 acres, and varies in width from about 7,000 feet near Fremont Weir to about 16,000 feet at Interstate-80. The design flow capacity ranges from 343,000 cfs at Fremont Weir to 500,000 cfs at Liberty Island (Corps, 1994a).

The Knights Landing Ridge Cut is about 6 miles long and extends from Knights Landing to the west bank of the Yolo Bypass. The Colusa Basin Drain and the Knights Landing Ridge Cut transfer drainage water from the west side of the Central Valley to the Yolo Bypass.

Physical Environment

<u>Geology</u>. California is separated into eleven geomorphic provinces of which the Great Valley, also known as the Central Valley or the Sacramento-San Joaquin Valley, is one of the largest. It is a nearly flat alluvial plain that extends from the Tehachapi Mountains on the south to the Klamath Mountains on the north and from the Coast ranges on the west to the Sierra Nevada on the east. The valley is about 640 kilometers (450 miles) long and averages about 80 kilometers (50 miles) wide and varies only slightly in elevation throughout its extent. Generally, elevations are just slightly below mean sea level (MSL) to about 120 meters (400 feet) above MSL. The

only prominent topographic feature in the northern part of the Great Valley is the Sutter (Marysville) Buttes, a Pliocene age volcanic dome complex (Corps, 1994b), which rises above the valley floor to an elevation of 640 meters (2,100 feet).

Geographically, the Great Valley is separated into two portions, the northern portion known as the Sacramento Valley and the southern portion known as the San Joaquin Valley. The north-east trending Stockton fault on the northern flank of the Stockton Arch is usually considered to be the dividing line between the two valleys.

The study area extends from the Tisdale Weir and Bypass in the northwest to the vicinity of Wheatland in the northeast and south to the vicinity of Putah Creek and Davis. Two major tributaries of the Sacramento River drain this area. They include the Bear and Feather Rivers along with numerous bypasses, canals, creeks, and sloughs. Present-day geological activity is primarily both deposition and erosion of sediments in the Sacramento basin and can be attributed to areal climatic variances. Overall, the State is dominated by nonmarine sedimentation, except for the narrow coastal shelf margin where marine sedimentation is presently proceeding. Relief in the study area is very slight, ranging from about 30 feet m.s.l. at Tisdale Weir in the north to about 15 feet m.s.l. at the confluence of Putah Creek and Yolo Bypass in the south.

Topography. The Sacramento River Basin is bounded by the Trinity Mountains on the north, the Sierra Nevada on the east, the North Coast Range on the west, and joins the San Joaquin Valley on the south. The Sacramento Valley is the central portion of the basin and extends 150 miles from Red Bluff in the north to Suisun Bay in the south. The valley varies 10 to 40 miles in width and ranges in elevation from about 300 feet above sea level to about 5 feet below sea level. Near the center of the valley, the Sutter Buttes, an old volcanic formation, rise abruptly to more than 2,100 feet and cover approximately 80 square miles of northern Sutter County.

Soils. Most soils in the affected project area are recent alluvium consisting of unconsolidated deposits of clay, silt, and sand, typical of soils found in a flood plain. This soil type tends to be very young because fresh sediments are deposited with each floodflow (particularly within the bypasses). These soils are some of the best in the county for crop production and support winter grains, annual range, irrigated pasture, rice, and orchards. In general, the study area is within the Bear, Feather, and Sacramento River flood plains or basins. The sedimentary deposits within this area are classified as either channel deposits, natural levees, or basin deposits (alluvium). Typically, sediments, other than

channel deposits, are transported in suspension and deposited outside the established river channels during periodic floods. These sediments are finer grained overbank deposits and are shown on the 1981 California Division of Mines and Geology map of the Sacramento Quadrangle as Qa (natural levee) and as Qb [basin deposits (alluvium)] (Corps, 1994b). The Qa designation on the geologic map is also used for the coarser grained channel deposits such as those sediments that are likely to be found in a stream or river channel.

Air Quality. The project is located in the Sacramento Valley Air Basin which comprises the northern half of the Central Valley. The basin is bounded by the Coast Range, the Cascade Range, the Sierra Nevada Range, and the San Joaquin Basin. Marine winds enter the valley at the Carquinez Straits and move eastward until they are deflected south into the San Joaquin Valley and north into the Sacramento Valley. The topographic boundaries of the basin contribute to accumulation of air pollutants, particularly oxidants from motor vehicles and suspended particulates from the agriculture and lumber industries.

Air quality has been monitored for the last two decades. Results show that the principal pollutants in the region are associated with motor vehicles and airborne solids and gases caused by agricultural activities such as burning of rice straw and dust from plowing (Sutter County, 1983).

Pollutants in the study area are most highly concentrated between May and October, corresponding to the time of year that the Pacific high pressure system dominates northern California and creates an inversion layer that suppresses the upward motion of air, trapping pollutants near the ground surface and up against the flanking mountain ranges of the basin. During this time of year, the wind direction is from the south, bringing higher concentrations of pollutants from Sacramento (Corps, 1991).

All five counties are in the Sacramento Valley Air Basin. Portions of each county are designated Air Pollution Control Districts. Each District has its own regulation applying to all stationary sources to control pollution emissions. These regulations have to coincide or coordinate with the regulations of the State and Federal governments in addition to the requirements of the Sacramento Valley Air Pollution Coordinating Council. The local district has primary responsibility for controlling stationary emission sources.

Local air quality management districts that are within the Northern Sacramento Valley Air Basin and subject to the Basin-wide Air Quality Attainment Plan are required to formulate local attainment plans (Yuba County, 1992). Sutter,

Yuba, Yolo, Placer, and Solano are designated by the U.S. Environmental Protection Agency as non-attainment areas. These counties have adopted regulations pertaining to activities which affect air quality. Their regulations control open burning, agricultural burning, industrial and commercial wastes, and emissions from residential areas.

Water Quality. Rivers and streams in the project area are part of the Sacramento River Basin. Numerous streams and rivers drain the western slopes of the Sierra Nevada and Cascades, emptying into the Sacramento River. Overall, water quality of the Sacramento River is good; however, water quality at specific sites may vary due to the effects of variations in streamflow and the quantity of local waste discharges and irrigation return flows. Higher sediment loads and extensive irrigated agriculture tend to degrade water quality. During the spring and fall, excess irrigation waters are discharged into drainage canals that flow to the river. In the winter, rainfall runoff flows over these same areas. In both instances, flows are highly turbid and introduce herbicides and pesticides into the drainage canals.

Water quality of the Feather River is considered good to excellent. Turbidity is highest in winter and spring, corresponding to the heavy runoff seasons. Tributaries to the Feather River provide the most potential for degradation in the spring and early summer. Tributary streams accept agricultural drainage as well as natural runoff (Corps, 1991).

The Sutter Bypass through the project area conveys water only during the flood season; these are excess flows from the Sacramento River and inflow from tributary streams (Corps, 1991). Surface waters from both the west and east sides of the Sacramento Valley drain into the Sutter Bypass. Water quality should be similar to the Sacramento River, but with increased turbidity. The two low flow streams (sometimes referred to as the east and west levee borrow ditches) lining the Sutter Bypass typically convey water from agricultural drainage and residual storm waters all year. The water quality of these streams is fairly good.

The Yolo Bypass is located immediately west of the metropolitan area of Sacramento and extends from the Fremont Weir downstream to Liberty Island, a distance of about 43 miles. During high flows in the Sacramento River, floodwaters are diverted into the bypass via the Fremont Weir and Sacramento Bypass and conveyed south around Sacramento. Additional flows enter the bypass from westside tributaries, including Willow Slough and the Willow Slough Bypass. Floodwaters reenter the Sacramento River upstream from Rio Vista. The bypass floods about once every 3 years, generally during December, January, and February. Water quality of

floodwaters should be similar to the Sacramento River, but with increased turbidity. Non-floodwaters consist of irrigation for agriculture, livestock, and private hunting clubs. Non-floodwaters exit the bypass through the toe drain in the eastside levee, primarily as low quality agricultural runoff (Corps, 1994a). Both surface and ground water in Yolo County are relatively high in boron. This is the major reason that little of the County's water can be classified as excellent for irrigation. During dry years when the flow is low, the boron and salinity impair the quality of this water for irrigation and its hardness makes softening desirable for domestic purposes (Yolo County, 1983).

The Knights Landing Ridge Cut is about 6 miles long and extends from Knights Landing to the west bank of the Yolo Bypass. The Knights Landing Ridge Cut is part of a complex system of agricultural water delivery and drainage channels located in the Central Sacramento Valley. The Knights Landing Ridge Cut acts primarily to drain agricultural drainage water to the Yolo Bypass. The irrigation drainage water transferred through the Knights Landing Ridge Cut is usually contaminated with pesticides and fertilizers. Therefore, the water quality of the Knights Landing Ridge Cut is seasonally poor as a result of high sediment loads and extensive agriculture irrigation discharges (Corps, 1992).

Biological Environment

Fisheries. The Sacramento and Feather Rivers provide important habitat for both anadromous and resident fish species. Anadromous fishes of the Sacramento River system in the project area include spring, fall and winter-run chinook salmon, steelhead trout, striped bass, American shad, white sturgeon, and green sturgeon. Resident warmwater fish of the Sacramento River include largemouth bass, catfish, bluegill, tule perch, and sunfish (FWS CAR 1995). Of greatest importance to California fisheries is the chinook salmon. The Sacramento River supports the largest chinook salmon population in the state. About 90 percent of the Central Valley salmon population spawns in this system (FWS, 1995). Total numbers of salmon that spawn in the Upper Sacramento River system have declined more than 75 percent since the 1950's (FWS, 1995). The winter-run chinook salmon is currently listed as a threatened species at the Federal level and an endangered species at the State level.

Fish resources of the Feather River include anadromous species such as chinook salmon, steelhead trout, American shad, striped bass, green and white sturgeon, and Pacific lamprey. The number of adult chinook salmon returning to spawn in the Feather River averages nearly 51,000, 15 percent of which return to the Feather River hatchery at Oroville.

About 20,000 steelhead trout use the Feather River for spawning and rearing. Spawning by both species takes place above Marysville (FWS, 1995).

The Feather River supports one of the only two known established populations of northern spotted bass in California. The other population resides in the Consumnes River. Spotted bass is an introduced species, brought to California from Ohio in 1933 (FWS, 1995). Irrigation ditches that parallel the landside levee toe in a few areas along the Feather River probably also support limited warm water fisheries such as catfish and carp.

The same anadromous fish species identified in the Sacramento River system are also occasionally present in several of the borrow ditches within the Yolo Bypass, such as the Tule Canal and Knights Landing Ridge Cut. Some of the borrow ditches adjacent to the levees support a significant warmwater fishery consisting of largemouth bass, crappie, catfish, and bluegill. Several nongame fish such as carp, suckers, several minnow species, and mosquitofish are also present. Most of the species found in the Sacramento River system may enter the Yolo Bypass during high flow events. There is little information available on fish population levels, habitat conditions, and sportfishing resources in the Yolo Bypass, borrow ditches, and canals within the Yolo Bypass (FWS, 1995).

As in the Yolo Bypass, fish species composition in the Sutter Bypass would be expected to be similar to those found in the Sacramento River. Fish surveys were conducted in the Sutter Bypass by Jones and Stokes Associates in May 1993. Species found included chinook salmon, Sacramento squawfish, Sacramento splittail, hitch, fathead minnow, carp, red shiner, golden shiner, Sacramento sucker, mosquito fish, inland silverside, threadfin shad, channel catfish, logperch, redear sunfish, bluegill, white crappie, large-mouth bass, and goldfish (FWS, 1995). Adult salmon and steelhead use the low flow streams of the Sutter Bypass in an attempt to reach spawning areas outside the bypass; however, there are no suitable spawning gravels within the bypass (FWS, 1995).

Many of the same species found in the Sacramento River would be expected to occur in the Knights Landing Ridge Cut. Specific species information is unavailable at this time (FWS, 1995). The Colusa Basin Drainage Canal and Knights Landing Ridge Cut do not provide consistently adequate flows or temperatures to support successful populations of winter-run chinook salmon. The warmer water may, however, attract fry and juvenile winter-run chinook salmon during their downstream migration from traditional spawning grounds above Red Bluff Diversion Dam on the Sacramento River. Warmer waters are more

productive, producing more food for the growing fish (Beak, 1991).

Vegetation

Sacramento and Feather Rivers. Within the project area, vegetation along the Sacramento and Feather Rivers varies in density, width, and species composition, depending on numerous physical parameters such as hydrology, elevation, land use, placement of riprap, location of levees, and levee maintenance practices (FWS, 1995). Cover types found include riparian woodland, riparian scrub-shrub, shaded riverine aquatic, permanent freshwater marsh, seasonal marsh, and annual grassland.

Riparian vegetation along the banks of the Sacramento River occurs in varying conditions in the project area. Where vegetation is present, it usually occurs in narrow but dense bands along the banks. Setback levees in some areas allow larger parcels of dense, high value riparian habitat to occur adjacent to the river. Much of the Sacramento River between Verona and the Tisdale Weir has undergone extensive bank protection work and levee maintenance. These practices have permanently eliminated or degraded much of the riparian vegetation in these areas, resulting in little, if any, habitat value for fish and wildlife species. Along the Feather River from its confluence with the Sacramento River to Highway 99, riparian forest habitat consists primarily of a dense, relatively wide band of vegetation on the west bank of the river. Vegetation on the east bank is relatively narrow and sparse due to the proximity of the river and levees to the Garden Highway (FWS, 1995).

Within the riparian corridor, tree canopy consists primarily of valley oak, sycamore, cottonwood, and willow. California grape and mistletoe are sometimes present. A well-defined woody understory typically consisting of box elder, black walnut, white alder, Oregon ash, blue elderberry, and smaller cottonwood occurs in most undisturbed areas. California grape, blackberry, mugwort, western ragweed, pigweed, clover, cocklebur, several thistles, grasses, and forbs form an often dense ground cover. Non-native woody species which may be commonly found include Eucalyptus, giant reed, and honey locust (FWS, 1995). Generally, riparian vegetation occurs up to the levee toe on the waterside of the levees.

Riparian scrub-shrub cover type is also found in the study area. It is defined as habitat dominated by woody vegetation less than 20 feet tall. Species include shrubs, young trees, and trees and shrubs that are small or stunted because of environmental conditions. Specific species found

in the study area include raspberry, wild rose, blue elderberry, box elder, valley oak, and black walnut. Mixed scrub-shrub areas typically consist of a dense thicket of three or more shrub and/or young tree species. Typical species are similar to the shrub and young tree understory species described for the dense, mature riparian forest habitat type.

Shaded riverine aquatic (SRA) cover is found along the margins of waterways where overhanging or submerged vegetation exists, usually along banks which have not been riprapped. This habitat provides diversity, cover, and often a cooler, shaded environment for fish and other aquatic organisms. Cover of this type may also be provided by irregular, uneven, eroding river banks. The productive interaction and synergism of terrestrial and aquatic habitat types associated with SRA habitat results in a valuable cover type for fish, providing a variety of microhabitats, with various flows, depths, cover and food production. Of particular note is the documented value of this habitat type on the Sacramento River to juvenile salmon as they migrate through the project area to the ocean (FWS, 1994).

Permanent freshwater marshes may be found in several reaches of the Sacramento and Feather Rivers and associated sloughs. They are characterized by persistent, dense stands of non-woody emergent vegetation. Common species include cattails, bulrush, umbrella sedge, smartweed, iceplant, California hibiscus, and marsh pennywort. Marshes provide critical feeding habitat and cover for certain waterfowl, such as surface-feeding and diving ducks, and for wading birds, such as egrets and herons (FWS, 1995). Seasonal marshes, such as those found in drainage ditches, may provide food, cover, and water for species such as the great egret. Riparian and emergent marsh vegetation occur along a number of seasonal irrigation delivery ditches found in the project area.

On the landward side, grassland and agricultural lands are most abundant. Levee slopes and berms may contain several varieties of grasses, forbs, and weeds. Some worksite grasslands also support some woody tree species such as cottonwood or willow. The lack of much woody vegetation is due mainly to levee maintenance activities, including burning, discing, spraying, and mowing. However, these areas provide valuable habitat for small mammals, such as rabbits and mice, which in turn provide a food base for larger animals such as coyotes and raptors (FWS, 1995).

<u>Sutter Bypass</u>. Narrow strips of riparian forest habitat line both banks of the river within the existing levees. In the project area, vegetation waterward of the levee consists primarily of very narrow strips of riparian habitat dominated

by cottonwoods, willows, alders, and oaks generally found in association with the adjacent borrow ditch. The levee slopes and landside toe of the levee are covered by herbaceous vegetation and are essentially void of any trees or shrubs (FWS, 1995). The majority of the land within the bypass are farmed. The Sutter National Wildlife Refuge is located within the bypass. The refuge is managed primarily for waterfowl and includes seasonal and permanent wetlands and feed crop areas.

Yolo Bypass. In the project area, vegetation waterward of the levee consists primarily of very narrow strips of riparian habitat dominated by cottonwoods, willows, alders, and oaks. The majority of lands within the bypass are farmed. The Board owns several hundred acres of land within the bypass, upstream and downstream of the Fremont Weir. This area is leased to the California Department of Fish and Game for their management as a wildlife preserve.

Knights Landing Ridge Cut. Riparian forest and freshwater marsh comprise the cover types found here. Dominant species found in the riparian forest include Fremont cottonwood, willows, California grape, and poison oak. Freshwater marshes in this area are permanently flooded by fresh water, lack a water current, and accumulate deep, peaty soils. Dominant species include cattails and bulrushes (FWS, 1995). Plant species found along the east side of Knights Landing Ridge Cut are listed in Appendix A of the FWS' 1995 CAR. Many of the species listed in Appendix A of the CAR may be found throughout the project area.

Annual grasslands are found at all project sites, primarily on the levee slopes. In many areas, grassland vegetation occurring on levee crowns is removed by burning or discing, or is prevented from establishing due to regular vehicle use. Most of the grassland habitat along the channel reaches is moderately to highly disturbed; characteristic plant species include star thistle, foxtail brome, wild mustard, and other annual grasses.

Wildlife. The composition, abundance, and distribution of wildlife resources in the project area is directly related to available habitat. Overall, fewer wildlife species now inhabit the project area than before agricultural development permanently removed much of the natural habitat. Many wildlife species are unable to adapt to other habitat types or altered habitat conditions. These species are therefore most susceptible to habitat loss and degradation. Species which were dependent on riparian woodland, oak woodland, marsh, and grassland habitats have declined accordingly (FWS, 1995).

Riparian forest, with its multi-strata structure, dense cover, and high plant species diversity, is especially

productive, supporting the highest numbers and diversity of wildlife species. In California, about 25 percent of native land mammal species, 50 percent of reptile species, and 75 percent of amphibian species depend on riparian habitats (FWS, 1995). Invertebrates, both terrestrial and aquatic forms, are also supported in high numbers by riparian habitats. Invertebrates provide essential food sources for birds and other vertebrates. Invertebrates regulate vegetative growth and pollinate most flowering plants, thus ensuring their reproduction. Restrictions in geographic movement make invertebrates especially vulnerable to habitat alteration (FWS, 1995).

The existing native habitat, especially the riparian corridors along the waterways, provides habitat for many native mammal species. Blacktail jackrabbit, western gray squirrel, red fox, gray fox, bobcat, raccoon, opossum, mink, longtail weasel, striped skunk, spotted skunk, badger, muskrat, river otter, and beaver are all found in the project area (FWS, 1995).

Native habitat also provides nesting and feeding habitat for resident birds. The Sacramento River system is part of the Pacific Flyway and provides important resting and feeding areas for migratory waterfowl, shorebirds, and other water-associated birds. Common bird species found in the project area include California quail, ring-necked pheasant, mourning dove, band-tailed pigeon, common merganser, mallard, great blue heron, great egret, belted kingfisher, marsh wren, song sparrow, various owls, various woodpeckers, red-tailed hawk, and Swainson's hawk (FWS, 1995). A complete list of bird species found along the Sacramento River is included in Appendix B of the FWS' 1995 CAR.

Amphibians and reptiles found in the project area include the gopher snake, western fence lizard, common garter snake, and Pacific tree frog (FWS, 1995).

Threatened and Endangered Species. The following is a discussion of Federally and State-listed threatened and endangered species that may occur in the proposed project area. The Corps and the Reclamation Board have coordinated with FWS and California Department of Fish and Game (DFG) biologists to identify species protected under the State and Federal Endangered Species Acts which may be affected by the proposed project. Appendix B is a Biological Data Report (BDR) for the project area including a list of Federal species of concern (dated April 18, 1995) and the results of a DFG NDDB Report (1994). The Corps and the Reclamation Board would coordinate with the FWS and DFG if surveys determine that the proposed project would adversely affect any threatened, endangered, or proposed Federally or State-listed species.

The National Marine Fisheries Service (NMFS) has responsibility for most marine fish, such as winter-run chinook salmon, and would be consulted on activities which may affect any such listed or proposed species in the project area. However, no construction activities are proposed that would adversely affect fish resources within the project area.

Thirteen Federally threatened, or endangered species may occur in the project area. The Federally listed endangered species are the winter-run chinook salmon, bald eagle, American peregrine falcon, vernal pool tadpole shrimp, Conservancy fairy shrimp, palmate-bracted bird's-beak, and Solano grass. The Federally listed threatened species are the delta smelt, giant garter snake, Aleutian Canada goose, valley elderberry longhorn beetle, vernal pool fairy shrimp, and delta green ground beetle.

In addition, five species which may occur within the project area are identified as proposed for Federal listing. The proposed endangered species are the California red-legged frog, Contra Costa goldfields, and Hartweg's golden sunburst. Proposed threatened species are Sacramento splittail and Colusa grass. A list of Federally listed candidate species is included in the FWS 1995 CAR and in the Corps' BDR.

The DFG was contacted regarding State-listed threatened and endangered species which may occur within the project area. Of the Federally listed species identified, seven are also State-listed species. These are winter-run chinook salmon, delta smelt, giant garter snake, bald eagle, American peregrine falcon, palmate-bracted bird's beak, and Solano grass. In addition to these seven jointly listed species, there are five species which are only State-listed and may occur within the project area. These species are bank swallow (threatened), Swainson's hawk (threatened), western yellow billed cuckoo (endangered), Colusa grass (endangered), and Hartweg's golden sunburst (endangered).

Plants. Habitat for the palmate-bracted bird's beak, a State and Federally listed endangered species, consists primarily of alkaline valley and foothill grassland, and chenopod scrub in which saltbush and greasewood frequently dominate. The plant is mostly found on alkaline soils and blooms in May to October. This plant is threatened by agricultural conversion, urbanization, and altered hydrology (FWS, 1995). The palmate-bracted bird's beak has a very limited range of occurrence and a need for specific growing conditions that are not found in the project area.

Solano grass, a State- and Federally listed endangered species, is a small, summer-blooming annual grass. It grows from 2 to 20 centimeters high. Its morphological distinctness

and evolutionary distance from all other grasses suggest that the family Orcuttieae constitutes an ancient relic tribe of grasses that perhaps was more widely distributed around the lakes and marshes that mantled most of the Central Valley in the recent geologic past. Most known populations of Orcuttieae, however, occur on relatively recently deposited lake bed soils suggesting recent origin or diversification. Orcuttieae, along with numerous other genera, compose taxa that have radiated extensively in the vernal pools of California (FWS, 1995). There is no vernal pool habitat within the project impact area.

Contra Costa goldfields, a Federally listed proposed endangered species, is a showy spring annual, usually less than or equal to 40 cm high. Contra Costa goldfields is found in vernal pools in open grass covered areas in the valley and foothill woodlands at elevations less than 100 meters. Contra Costa goldfields is endangered throughout its range and endemic to California (Corps BDR, 1995). Contra Costa goldfields occurrence is limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported. Currently, Contra Costa goldfields is found only in vernal pool habitat of Solano and Napa Counties (Corps BDR, 1995). Contra Costa goldfields has a very limited range of occurrence and there is no vernal pool habitat within the project impact area.

Colusa grass, a State endangered and Federally listed proposed threatened species, is a vernal pool inhabitant and is endemic to California. The plant is found in valley clay pan soils and in saline alkaline basins. In upland habitat, these plants are found in fans and terraces from 100 to 4,500 feet in elevation. Colusa grass is a very rare plant species (FWS, 1995). There is no vernal pool habitat within the project impact area.

Hartweg's golden sunburst, a State endangered and Federally listed proposed endangered species, is generally found on low rolling hills in valley grassland. All of the sites located for this plant have been associated with mima mound topography (raised mounds), which is often associated with nearby vernal pools. Hartweg's golden sunburst is found predominantly on the northern slopes of knolls, but also along shady creeks or near vernal pools with clay soils, between 50 to 460 feet in elevation (FWS, 1995). There is no mima mound/vernal pool habitat within the project impact area and no project repairs area proposed within the limited range of this species.

Birds. The bald eagle, a State- and Federally listed endangered species, is known to migrate through, and winter in, the San Joaquin Valley. It feeds mainly on fish but will

also eat water birds and mammals. The bird perches high in large, stoutly limbed trees, on snags or broken-topped trees, or on rocks near water. It requires large bodies of water or free-flowing rivers with abundant fish, and adjacent snags or other perches. The bald eagle breeds in February through July; peak activity is March to June; and 87 percent of nest sites are located within 1 mile of water. The bird is monogamous and breeds first at year 4 or 5, with an average clutch size of two eggs (FWS, 1995). Populations of bald eagles have seriously diminished in number due to shooting, pesticides, and human encroachment. The bald eagle is a highly transitory species throughout the project area and nesting is not expected to occur.

The American peregrine falcon, a State- and Federally listed endangered species, is an uncommon breeding resident and an uncommon migrant to California. Important yearlong habitats include riparian areas and coastal inland wetlands. Protected cliffs and ledges are needed for cover. The bird breeds in woodlands, forests, and coastal habitats, and the breeding period is from early March to late August (FWS, 1995). The bird is not known to nest in the proposed project area; however, falcons may occasionally be found foraging in the area in the fall and winter months. Peregrine falcons eat a variety of birds, mammals, fish, and insects (FWS, 1995). The American Peregrine falcon is a mobile fall and winter migrant and no suitable nesting habitat exists in the project impact area.

The Aleutian Canada goose, a Federally listed threatened species, is a subspecies of the Canada goose. Preferred habitats include lacustrine, fresh emergent wetlands, moist grasslands, croplands, pastures, and meadows. It feeds on green shoots, seeds, wild grasses, forbs, and aquatic plants. The bird nests mainly from March to June and prefers to nest near water on a dry, slightly elevated site, with good visibility from the nest (FWS, 1995). It will also use manmade structures such as platforms, baskets, and artificial rock islands (FWS, 1995). This species migrates from the Aleutian Islands to winter in the central valley. Preferred winter habitat are dry or flooded corn, rice and other agricultural fields with stubble or low cover. Migrating Aleutian Canada geese may rest and forage within the Mid-Valley project area but would probably be reluctant to feed or rest in areas in or near construction sites. An abundance of suitable wintering habitat for the Aleutian Canada Goose exists throughout most of the Mid-Valley area.

The bank swallow, a State threatened species, is the smallest north American swallow. It is a small brown-backed swallow with a distinct dark breastband. This species migrates from South America to the central valley of

California where it breeds. Bank swallows are colonial nesters. Preferred nesting habitat are vertical banks found in association with riparian areas. Most of California's remaining population nest along the upper Sacramento River, with a few colonies found along the Feather River. Despite significant recovery efforts the species is still in decline. Loss of nesting habitat is a major factor in the significant decline of this species. The bank swallow occurs within a very limited range of the Mid-Valley project area due tc lack of suitable habitat.

Swainson's hawk is a State threatened species. It is a medium sized hawk with long pointed wings and a square tail. Its color is variable ranging from dark to light, but generally dark above and light below. This species is migratory, wintering in south and central America, and breeding in the western United States, including the central valley of California. In the central valley these birds nest primarily in very tall trees, usually found in association with riparian systems. Nesting locations which have minimal outside disturbances, and that are in close proximity to more open foraging lands are preferred. Suitable nesting habitat for Swainson's hawk exists within the vicinity of many of the proposed repair sites.

Western yellow billed cuckoo is a State endangered species. It is a slender bird slightly larger than a mockingbird. Its coloration is primarily brown above with white underparts. In flight its wings are cinnamon color. It has a long tail with white spots. This species is migratory, wintering in south American and nesting primarily in the Sacramento Valley. This species has declined dramatically, primarily due to loss of habitat. Preferred nesting habitat is large stands of deciduous riparian forest, preferably with a high willow composition. The occurrence of Western yellow billed cuckoo is extremely rare within the project area because of it's need for large riparian stands for nesting habitat.

Amphibians. The California red-legged frog, a Federally listed proposed endangered species, inhabits streamsides, grasslands, woodlands, and humid forests. It favors areas where cattails and other plants provide good cover. It is most common in lowlands and foothills and usually near a permanent source of water. It may, however, appear far from water in damp woods or meadows after a rainfall. The breeding period is in the rainy months of January through April. Egg masses are laid in a water source on emergent vegetation. The California red-legged frog has a very limited range of occurrence and is thought to no longer occur on the Sacramento Valley Floor.

Reptiles. The giant garter snake, a State- and Federally listed threatened species, inhabits sloughs, ponds, small lakes, low gradient streams, and other waterways such as irrigation and drainage canals. It feeds primarily on small fishes and frogs. Some habitat requisites consist of adequate water during the snake's active season (early spring through mid-fall) to provide food and cover, and emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season. The giant garter snake inhabits small mammal burrows through its winter dormancy period (November to mid-March). The breeding season extends through March and April, and females give birth to live young from late July through early September. Clutch size is variable, ranging from 10 to 46 young. Urban expansion, flood control projects, and other human activities currently threaten the survival of this snake throughout its range (FWS, 1995). Suitable habitat is available with in the landside irrigation ditches of the project impact area for the giant garter snake to occur (Sites 3, 5, 12, 13, 15A, and 19).

Fish. The winter-run chinook salmon, a State- and Federally listed endangered species, is a unique population of chinook salmon that spawns in the Sacramento River and is distinguishable from other chinook salmon runs found in the river based on the timing of its upstream migration and spawning season. Flow modification, water diversions, and loss of spawning and rearing habitat are thought to be major factors contributing to the decline of the winter-run chinook salmon. Currently, about 95 percent of winter-run chinook salmon spawning occurs between Keswick Dam and Red Bluff Diversion Dam; the remainder occurs downstream of Red Bluff Diversion Dam (FWS, 1995). The proposed project would not include any instream work.

The delta smelt, a State- and Federally listed threatened species, is a slender-bodied translucent planktivorous fish known to occur in the San Francisco Bay Estuary. It is the only true native estuarine fish in the Estuary (FWS, 1995). Delta smelt typically have a 1-year life span. Adults enter dead-end sloughs and channel edge-waters of the Delta to spawn between about February and June. Juveniles also feed on zooplankton. The proposed project would not include any instream work.

The Sacramento splittail, a Federally listed proposed threatened species, is a large (up to 40 centimeters) minnow endemic to California's Central Valley. The species has been restricted to a small portion of its former range and is now found primarily in the Sacramento River and Sacramento-San Joaquin Delta, Suisun Bay, Suisun Marsh, and Napa Marsh (FWS, 1995) The proposed project would not include any instream work.

Invertebrates. The valley elderberry longhorn beetle, a Federally listed threatened species, has been found only in association with its host plant, the blue elderberry. Adults feed on the foliage and perhaps flowers and are present from March through early June. In the spring the beetles mate, and the females lay eggs on living elderberry plants. After transforming into an adult within the plant, the beetle chews an exit hole and emerges from the elderberry. Elderberry shrubs and trees with beetle populations occur in a variety of habitats and plant communities, but most often in riparian or savanna areas (FWS, 1995). Elderberry plants and possibly the VELB can be found at several project locations (Sites 12, 12A, & 20).

Habitat for the Federally listed threatened vernal pool fairy shrimp, and the Federally listed endangered vernal pool tadpole shrimp and Conservancy fairy shrimp, consist entirely of vernal pools. There is no vernal pool habitat within the proposed project impact area.

The Delta green ground beetle, a Federally listed threatened species, is a tiny green beetle with striking metallic green coloration and diurnal predatory habits. The Delta green ground beetle resembles a tiger beetle much more than its close relative, the ground beetle. The Delta green ground beetle forages on damp, open ground in the late morning and early afternoon when temperatures are fairly high and the winds minimal. The beetle emerges and lays eggs in early February or earlier. The Delta green ground beetle aestivates through the summer and fall. The only known habitat for the Delta green ground beetle is in the playa pool habitat of the Jepson Prairie Preserve. There is no playa pool habitat within the project impact area.

Cultural Resources

Cultural resources may include buildings, structures, objects, sites, districts, and archeological resources associated with historic or prehistoric human activity. If determined to be significant, such resources may be designated as historic properties and become eligible for listing in the National Register of Historic Places. These properties may be important for their historic, architectural, scientific, or social values and may be significant at the national, state, or local levels.

A number of laws and regulations require Federal agencies to consider the potential effects of a proposed project on cultural resources. Principal among these is the National Historic Preservation Act of 1966, as amended (Public Law 95-515). In particular, the review process set forth in Section 106 of the act and its implementing regulations (36 CFR 800) prescribe the manner in which this law is carried out.

Prehistoric Background. The study area encompasses two distinct cultural areas, one centering around Oroville and the other in the Central Valley. Neither has been well studied, but general patterns and trends of their prehistoric records have been the subject of considerable debate. Archeological work near Oroville has recognized four different phases, the earliest known as Mesilla (1000 B.C. - A.D. 1), followed by the Bidwell (A.D. 1 - 800), Sweetwater (A.D. 800 - 1500), and Oroville (A.D 1500 - 1830).

The Central Valley-Delta prehistory is dominated by archeological investigations in the Delta. From the 1930's on, patterns emerging from those investigations led to the development of a tripartite temporal scheme, the Central California Taxonomic System. This scheme was organized into Early, Middle, and Late Horizons but was replaced in the 1970's by a pattern-aspect program. The earliest occupation in the lower Sacramento Valley began about 3000 B.C. (Windmiller Pattern) but gave way to the Berkeley Pattern around 1000 B.C. Those patterns remained in place until around A.D. 500 when the Augustine Pattern populations moved into the region (Par Environmental Services, 1992).

Ethnographic Background. The project area is located in two separate major ethnographic areas. These areas have been defined on the basis of linguistic affiliation, not social or political organizations. The Konkow occupied lands in the north near Oroville. Below that group resided the Nisenan Maidu linguistic group. Both groups functioned as individual units or autonomous tribelets, regardless of linguistic affiliations of their neighbors. Both were based on village communities of clustered dwellings. Villages were generally located on natural rises along watercourses.

Subsistence was based on procurement and storage of large amounts of food, particularly deer, fish, nuts, seeds, roots, and insects. Because many of these resources were abundant in the study area, evidence of some large populations and high densities can be found. Their social structure was based on the hierarchical model; however, the headsman did not possess coercive power over his community (Far Western Anthropological Research Group, 1990).

Historical Background. The Spanish did not settle the study area but did send occasional groups of explorers into the Central Valley prior to 1824. During the Mexican period, exploration and settlement of the Sacramento Valley was sporadic. Fur trappers were active in the area between 1820 and 1845. Settlement began with the arrival of John Sutter at the confluence of the American and Sacramento Rivers in 1839. The Mexican government issued several land grants in the study

area prior to the acquisition of California by the United States in 1848 (Far Western Anthropological Research Group, 1990).

Ranching and farming were the chief occupations of the early settlers of the Central Valley. Miners, unsuccessful in the mines, moved into the fertile valley to farm. These farms were originally located along the rivers to take advantage of the rich sediments deposited by natural overflows. As early as 1860, farmers were constructing their own levees in the vicinity of Marysville and Yuba City and in other locations along the Feather and Bear Rivers to protect their farms. Eventually, State and Federal plans for comprehensive flood control in the Sacramento Valley replaced these private efforts (Far Western Anthropological Research Group, 1990).

Summary of Cultural Resource Investigations. A review of records held by the Information Center of the California Archeological Survey at California State University, Chico, revealed that no properties that are listed or eligible for the National Register of Historic Places lie within the proposed project areas of potential effect. Information records did reveal, however, that a single prehistoric site, (CA-Sut-11) exists within this area, and three additional prehistoric sites (CA-Sut-1, 2, and 16) lie within one mile of the project area. Site CA-Sut-11 is a prehistoric burial mound recorded in 1934 by R.F. Heizer. He noted that this mound could be "a key mound to Sacramento archeology." The three prehistoric archeological sites lying outside the project area are also burial mounds.

Two separate cultural resources surveys covered the entire project area. A 1990 archeological survey (Far Western Anthropological Research Group, Inc.) confirmed the presence of archeological site CA-Sut-11 within the project area of potential effects in Site 19. Auguring at the site revealed a subsurface deposit of cultural materials at least 40 centimeters in depth which would suggest that the site retains a certain degree of integrity from the time it was first recorded in 1934. No additional cultural resources sites or values were located within the project area by the 1990 survey.

A 1992 cultural resources survey (Par Environmental Services, Inc.) identified a single cultural value within the project area of potential effects at Site 12A. This was an historic period site (receiving the temporary site number AC-S-2) located on the east side of the Knights Landing Ridge Cut in Yolo County. The resource was noted to consist of a surface distribution of farming and ranching equipment and domestic debris, probably associated with agricultural use in the surrounding region during the first half of the 20th

century. This survey identified no additional cultural resources within the project area.

Further cultural resource investigations are necessary to document historic values, determine adverse affects and recommended appropriate mitigation for historic sites located within the project area. Cultural resources surveys would be conducted by a qualified archaeologist in the project area to determine precise adverse affects and mitigation for historic sites. The results of these surveys would be reported to the State Historic Preservation Office prior to the finalization of this document.

Recreational Resources

The waters of the Sacramento and Feather Rivers draw people to the Mid-Valley area. Various recreational activities are actively pursued along the banks of the Sacramento and Feather Rivers and the remainder of the study area. The beauty of the rivers and their associated riparian vegetation attract a rich variety of birds and other wildlife. These features, in turn, attract recreationalists in pursuit of hiking and nature study. The levee crowns are sometimes used for hiking and biking. However, such use is restricted in many areas, and the public is not allowed to use most of the levee crowns for recreation. A biking/hiking trail runs along the Bear River from its confluence with the Feather River to Camp Far West Reservoir.

Consumptive use of wildlife is also a common recreational use in the project lands. Fishing is a major recreational activity in this area. The Sacramento and Feather Rivers offer American shad, chinook salmon, and steelhead fishing. An estimated 250,000 angler days are expended annually for salmon and steelhead on the Feather River. Hunting for duck and other waterfowl is also pursued in the Mid-Valley Area. Excellent bird hunting can be found throughout Yolo County.

Several parks are used for recreation within the Mid-Valley area. Sutter County does not have a park and recreation department and does not provide recreational facilities or opportunities through County programs. A variety of parks and recreation opportunities are located in the unincorporated area of Sutter County. However, there are no county park and recreation districts which serve the unincorporated area.

The City of Wheatland in Yuba County owns a 5.7-acre park site and a community park located on part of a 40-acre school site owned by the Wheatland Elementary School District (Yuba County, 1973). The natural setting of Yuba County provides a variety of physical environs for outdoor recreation. Some of

the County's natural resources, such as water and forest lands, are the basis for many recreation activities. The numerous rivers, streams, and reservoirs within Yuba County are extensively used for recreational purposes. Where access is available, fishing, picnicking, rafting, tubing, and swimming are the primary recreational uses of the Feather and Bear Rivers.

Yolo County hosts a wide variety of recreation areas although most are not developed sites. Hunting, fishing, boating, hiking, camping, river rafting, and biking can be found along the Delta, rivers, foothills, and valley. The county maintains some rural park and/or access areas: Putah Creek fishing access, Esparto and Sam Combs Park, boat launchings at Knights Landing and Clarksburg, and the River Bend Golf Course. The Putah Creek recreation beach, Helvetia Park, and approximately 12 marinas on the Sacramento River are privately owned, public recreation facilities in Yolo County.

The unincorporated areas of Placer and Solano Counties that contain small county communities must rely on neighborhood and community park and recreational facilities in distant areas.

Also located within the project area are several areas set aside for wildlife. Although the primary objective of these areas is the preservation of habitat for wildlife, these areas also attract recreational users such as anglers and hunters, where these uses are allowed, and hikers, campers, and birdwatchers. The Bobelaine Sanctuary, operated by the Audubon Society, is located south of Marysville along the west bank of the Feather River. The sanctuary's southern terminus is one-half mile north of the Highway 99 bridge; its northern terminus is just north of Laurel Avenue. The area has primarily riparian vegetation. Recreational opportunities consist of bird watching, nature study, and hiking.

The DFG operates several areas that are managed primarily for wildlife but also offer recreational opportunities. The Feather River Wildlife Area includes the Lake of the Woods unit (nearly 700 acres located along the east bank of the Feather River north of its confluence with the Bear River), the Nelson Slough unit (approximately 500 acres located along the Feather River from its confluence with the Sutter Bypass to one-half mile upstream of Highway 99), the O'Connor Lakes unit (363 acres located east of Tudor), and the Abbot Lakes unit (430 acres also located east of Tudor), all located along the Feather River. The Sutter Basin Wildlife Area, also operated by DFG, contains 624.25 acres and is located 20 miles southwest of Yuba City. The wildlife area encompasses the Tisdale Bypass from the auto bridge at the Sacramento River to its confluence with the Sutter Bypass, including both levees

and extending south in the Sutter Bypass along the east borrow ditch on the waterside (east) and the Sutter Mutual Water Company canal on the landside (west) of the levee. DFG also leases several hundred acres upstream and downstream of the Fremont Weir in Yolo County which is managed as a wildlife refuge. In general, these State DFG areas consist of river bottom riparian vegetation. Recreation in these units consists of shotgun and archery hunting for deer, quail, turkey, duck, and tree squirrel; angling; bird watching; and nature study.

The Sutter National Wildlife Refuge, located within and along the Sutter Bypass between the Tisdale Bypass and State Highway 20, consists of approximately 3,000 acres along 20 miles of riparian channels on both sides of the interior of the Sutter Bypass. The Sutter National Wildlife Refuge is operated by FWS. The Oroville Wildlife Area is located at the northern terminus of the project along the Feather River adjacent to the Thermalito Afterbay. Visitors to this area can enjoy camping, hiking, fishing, and hunting among wetlands, canals, and ponds.

The Yolo Bypass is used for agriculture, grazing, and private hunting clubs. The Reclamation Board owns the land in the Sacramento Bypass and leases it to DFG who manages it as a portion of the Sacramento National Wildlife Refuge. The remaining lands in the bypasses are privately-owned farmlands.

Esthetics

The esthetic resources in the Mid-Valley area are predominantly related to rivers or other running water and the associated vegetation. Vegetation types generally range from agriculture/grasslands to orchards to emergent marsh to riparian woodland to scrub-shrub. The slow moving rivers, lush riparian vegetation, and abundant bird activity could easily be considered the high point of central valley scenery. The esthetic quality is enjoyed by those who go to enjoy the beauty of the rivers and those who enjoy the esthetic quality while on their way to another destination. The Sacramento and Feather Rivers and associated riparian vegetation can provide a high quality visual experience for those who visit the banks or travel along the levees.

Visually, the rivers provide a focus for the towns in the area. The rivers give Knights Landing, Nicolaus, Robbins, and other nearby towns their unique character. Although the levees obscure views of the river from many vantage points in the towns, the riparian vegetation above the levees is visible from places in town and from Highways 99, 70, and 113, and Interstates 5 and 80. Highways 99 and 70 are considered State scenic highways.

From Tisdale Bypass to Sacramento, much of the waterside berms of the Sacramento River are devoid of riparian vegetation, and large portions of the original berms have been eroded so that the riverbanks are now adjacent to the levees. Below Sacramento, the Sacramento River is fairly slow moving, and the main river and its tributaries and sloughs are turbid and generally confined between the adjacent levees.

The largest community along the Sacramento River in the Mid-Valley area is Knights Landing where levees change visually from rural to a small community setting. This area is not generally of high visual quality because there is an absence of riparian vegetation in many sections of this reach of the river.

The Knights Landing Ridge Cut and vicinity is characterized by flat, agricultural landscapes with manmade modifications including levees and farming equipment. Riparian vegetation exists on the waterside of the Knights Landing Ridge Cut levees and on islands located within the ridge cut. Landward of the levee, the landscape is agricultural and of moderate visual quality.

Along the Feather River, the rural landscape consists primarily of the river, riparian vegetation, orchards, and an occasional park. The largest community along the Feather River in the Mid-Valley project area is the unincorporated community of Nicolaus. Many sites along the Feather River are high in visual quality. The resources within viewing distance of the river consist of large expanses of riparian and scrub-shrub vegetation which is not degraded or interrupted, offering cohesive views of the landscape. The Sutter Buttes are visible from many of the Feather River sites.

The visual quality along the Sutter and Yolo Bypasses is moderate to high. The dominant visual element in this area is agricultural and grazing fields. Riparian vegetation is present along the canals of the Sutter Bypass. Existing natural vegetation along the Yolo Bypass is limited to small, scattered areas along irrigation canals and toe drains. Raptors, waterfowl, wading birds, shorebirds, and songbirds may be seen visiting the area or flying in the vicinity. Private hunting clubs have preserved some areas of open water and natural vegetation that provide a positive esthetic experience for the viewer. The remaining lands in the bypass are privately-owned farmland. Flowage easements allow passage of floodwaters and clearing of brush, trees, and other obstructions. Landward of the levee, the landscape is agricultural and of moderate visual quality.

The visual quality near each worksite is moderate. The Sacramento and Feather Rivers are visible from the levees, and

there is riparian and scrub-shrub vegetation in the vicinity. However, the dominant visual elements in the area are agricultural land and orchards.

Hazardous, Toxic, and Radiological Waste

A survey of potentially hazardous, toxic, and radiological waste (HTRW) sites was conducted by the Corps' Environmental Design Section, Geotechnical Branch. The construction sites along the Sacramento River, Yuba River, Knights Landing Ridge Cut, Yolo Bypass, and the Sutter Bypass were surveyed for any materials which are causing, or have a potential to cause, contamination of the levees. Construction staging areas and borrow areas associated with the area were also surveyed. Areas where HTRW exist are detrimental to the authorities' ability to fight floods, inspect levees, and repair damaged or unstable areas. The results of the survey were documented and are on file with the Corps' Sacramento District office.

Each site was patrolled by foot or mountain bike for above-ground storage tanks, 55-gallon drums, stained soils, and dying vegetation. Nearby streets were surveyed for possible off-site polluters. Examples of such polluters are oil suppliers and distributors, crop dusting firms, gas stations, or any company or farm with underground storage tanks. Possible off-site polluters were documented due to the possibility of contaminant plumes in the soil or the presence of ground water underneath the HTRW.

All farmhouses in the rural areas along these levees tend to have one or more above-ground storage tanks. Only those tanks located at the staging or borrow areas or within 50 feet of the levees were documented. Above-ground storage tanks are generally not a major concern because leaks are easy to detect. These tanks are documented in case they need to be relocated and because poorly maintained tanks or sloppy filling practices may have resulted in soil contamination.

No known contamination was discovered within the right-of-way (ROW) of the various project sites. Five areas, with potential contamination were located outside of the project sites' rights-of way, but within a quarter mile of the project. Further investigation of the five areas with potential contamination is recommended to confirm the absence of contamination. No specific or unusual-environmental concerns have been identified that would significantly affect the proposed project. However, there remains the possibility that undiscovered soil or ground water contamination exists within a site ROW. In addition, all of the project sites are located adjacent to farming areas and/or orchards and may contain soil and ground water with concentrations of petroleum

hydrocarbons or agricultural chemicals. It is possible that ground water and irrigation water from the areas adjacent to the ROW may be migrating towards the project sites.

To determine the presence of environmental contamination in the ROW, additional investigation was conducted at the site 5 gap, site 10, site 15, site 18, and the gap between sites 18 and 20. This included obtaining a right of entry from the Reclamation Districts, visiting the five sites, and conducting a visual observation at each site. In addition to the 5 sites recommended for additional investigation, all other sites proposed for construction were also visually inspected and the ROW are located 20 to 90 feet from the levee toe in rural areas. The Sutter County Environmental Health Department was contacted concerning any known contaminated sites within any of the project ROW's located within Sutter County. One known site is approximately one-half mile north of Site 2. A sediment sample was taken in the Sutter Bypass under the south bridge of Highway 113 during routine sampling of the bypass by the State Water Resources Control Board. The test results indicated that the sample contained polynuclear aromatic hydrocarbons at a concentration of 0.6 part per million (ppm) (Corps, 1994). Further investigation of the five areas with potential contamination is recommended to confirm the absence of contamination. Additional investigation is not required if no evidence of contamination is found at the site.

Any contaminated soil or ground water which is found on a project site during construction would be a concern. Construction workers could be exposed to contamination during construction of the slurry cut-off walls into shallow ground water or relocation of a ditch at the base of a levee. A contingency plan would be developed by the Corps in coordination with the Reclamation Board. An Environmental Site Assessment for the Sacramento River Flood Control System Evaluation Phase III Area was prepared in September 1994. This assessment provides further details of HTRW contamination in the project area and is on file at the Corps' Sacramento District.

Socioeconomics

Land Use. The project is located within parts of Sutter, Yuba, Yolo, Placer, and Solano Counties. Sutter County lies near the center of the Sacramento Valley. Sutter County contains a total of 388,480 acres of surface area. A little less than 4,000 acres are included in the two incorporated communities, and about 5,000 additional acres are devoted to non-agricultural uses. The vast majority of land--over 97 percent--is devoted to agricultural uses. Farming is the County's most important industry. Crops such as prunes, melons, peaches, grain, beans, clover, rice, pears, tomatoes,

and walnuts are produced in Sutter County. Sutter County has within its boundaries two incorporated cities--the City of Yuba City and the City of Live Oak. The major portion of the urban population is centered in or around the City of Yuba City, while several unincorporated communities such as East Nicolaus, Trowbridge, Robbins, Sutter, Meridian, and Tierra Buena house most of the rural unincorporated population of Sutter County. The portion of Sutter County in the project area includes the Tisdale and Sutter Bypasses and the Sacramento and Feather Rivers (Sutter County, 1983).

The Sutter Bypass conveys overflow from the Sacramento River, and no residential or commercial development is allowed within the bypass. During the non-flood season, the bypass is farmed. A portion of the Sutter Bypass is also designated as a national wildlife refuge and is managed for wildlife in coordination with its primary purpose of flood control.

The portion of Yuba County located in the Mid-Valley study area is the area encompassed by the Feather River, Western Pacific Intercept Canal, Best Slough, Dry Creek, and the Bear River. Land within the levee system of the Feather River and tributaries is agricultural, undeveloped, or used for wildlife and recreation. Percolation ponds also exist in several locations on the waterside of the Feather River levees. On the landward side, agricultural uses include extensive orchards, row crops, and grain fields. The Marysville and nearby Linda and Olivehurst communities form the urban core. Residential development and small residential tracts are scattered throughout the unincorporated areas. Conversion of agriculture to urban development is ongoing, particularly in the Linda-Olivehurst area.

Approximately 300,000 acres of land are being used for farming and grazing in Yuba County. There are approximately 90,000 acres of irrigated agricultural land. Rice is the predominant irrigated crop, followed by peaches, prunes, walnuts, pears, almonds, wheat, irrigated pasture, kiwi, alfalfa, milo, beans, and miscellaneous vegetable crops. The non-irrigated lands (200,000 acres) are mostly dry farmed in barley or used for pasture. In the foothills, raising livestock is the main agricultural activity. A small acreage is used for hay and irrigated pasture (Yuba County, 1988).

Yolo County encompasses about 1,034 square miles and is situated near the southern end of the Sacramento Valley immediately west of Sacramento County. Yolo County's western boundary lies at the top of the Blue Ridge of the Vaca Mountains while its eastern boundary is the Sacramento River. Most of the 661,760 acres in the county are in agricultural production. Eighty-five percent of the agricultural lands in the county are contracted to remain in agricultural land uses.

Annual agricultural production is nearly $250 million per year (Yolo County, 1983). The cities of Woodland, Davis, West Sacramento, and Winters and the communities in east Yolo are the major urbanized areas in the county. A number of small farm community centers are scattered throughout the county. Manufacturing and support industries for the agricultural activities of the county are found in the industrial areas of Davis, Woodland, and West Sacramento. Additionally, a number of trucking companies are located in West Sacramento, and the International Port of Sacramento is located in the southern part of that urbanized area. Besides the Sacramento River, the county has two major steams, Cache Creek and Putah Creek, which empty into the Yolo Bypass.

Significant urban redevelopment is proposed for parts of the West Sacramento area while additional new growth areas are limited by careful planning and re-zoning throughout the urban areas of Yolo County.

The Federal Government owns 28,814 acres of Yolo County's land. The State owns 76,869 acres of land which includes the university farm and Davis campus of the University of California and its research fields and the State Highway rights-of-way. Also, the Reclamation Board uses some land in connection with its flood control system. The county owns 2,279 acres; the cities own 5 acres; school districts own 414 acres; and special districts own 13,664 acres. Another 141 acres consist of an Indian reservation of the Patwin Indians in the Capay Valley. Other public holdings include a State Forestry nursery near Davis, county fairgrounds near Woodland, vacant school lands, and some State acreage obtained through tax negligence. Of the County's 1,035 square miles, 1,028 square miles are land, and 6.8 square miles are water (Yolo County, 1983). The portion of the project area in Yolo County includes the Sacramento River, Knights Landing Ridge Cut, and the Yolo Bypass.

The Yolo Bypass lies in a general north to south orientation and extends 43 miles from the Fremont Weir downstream to Liberty Island. The Yolo Bypass is bounded by levees except for the high ground on the west side downstream from Putah Creek. The Yolo Bypass is operated and maintained as a component of the Sacramento River Flood Control Project. Land use within the bypass is predominantly agriculture during non-flood periods.

The Knights Landing Ridge Cut is about 6 miles long and extends from Knights Landing to the west bank of the Yolo Bypass. The Colusa Basin Drain and the Knights Landing Ridge Cut transfer drainage water from the west side of the Central Valley to the Yolo Bypass.

Placer County, located in northeastern California, covers approximately 1,500 square miles of diverse geography between Sacramento and the Nevada border. The western part of the county, which is part of the Sacramento Valley, is generally flat and ranges in elevation from 45 to 1,000 feet. This part of the county, called South Placer, contains the cities of Roseville, Rocklin, Lincoln, and Loomis, as well as the unincorporated communities of Sheridan and Granite Bay. The South Placer area contains Yankee Slough, the only portion of Placer County that is located in the project area. The South Placer area has experienced the county's most significant growth in recent years, both in terms of new housing and commercial and industrial development. Most of the county's major manufacturing facilities are located in this part of the county. South Placer County also supports the bulk of the county's agricultural activities, including over 86,000 acres of land enrolled in California Land Conservation Act (Williamson Act) contracts (Placer County, 1993).

Solano County is in the west-central area of California. The county extends into low-lying foothills and steeper uplands of the coast ranges along the western edge. Except on the west, most of Solano County is bordered by waterways. Putah Creek forms the northern boundary; Steamboat Slough and the lower Sacramento River form the southeastern boundary; and Suisun and San Pablo Bays (easterly extending arms of San Francisco Bay) form the southern boundary. Much of the unincorporated area is devoted to agricultural uses, and there is little concentrated development outside incorporated areas except for a few rural residential communities. A portion of eastern Solano County is part of a vast low-lying tidal area known as the Sacramento-San Joaquin River Delta. Commonly referred to as the "Delta," it consists of highly productive farmland reclaimed from swamps by levees that divide it into tracts, locally known as "islands." The lower end of Yolo Bypass, a leveed floodway that is part of a joint Federal-State improvement of the lower Sacramento River and its tributaries for flood control, is located in the Delta region of Solano County. All the lands in the bypass are either owned by the State of California or are covered by flowage easements held by the State. These lands are intensively farmed except during winter when floodflows are normally expected. A portion of Putah Creek, which drains a narrow band along the far northern boundary of the county, is the only portion of Solano County that is located in the Mid-Valley project area.

<u>Population and Housing</u>. The 1990 census credited Sutter County with a total population of 64,415, a 22.3 percent increase over the 1980 census population of 52,246. In early 1991, the Sacramento Area Council of Governments (SACOG), in cooperation with the City of Yuba City and County of Sutter,

prepared new population projections for Sutter County for each 5-year period until the year 2010. With the adoption of the south Sutter County General Pan Amendment, the Sutter County Planning Department modified the 1991 projection series to reflect development in the South County Urban Area starting to occur about 1995. The modified series projects a county total population of just over 151,600 by the year 2010. This reflects an annual growth rate of 4.4 percent. This rate is higher than the 2.1 percent annual growth experienced during the 1980's. The higher rate of growth projected over the next 20 years is thought to be realistic of future development trends. With the adoption of the South Sutter County General Plan Amendment, 25,000 acres near the Sacramento housing market will become available for urban uses after completion of specific plans (Sutter County, 1994). A significant factor in recent growth has been development pressures from the Sacramento metropolitan area. The availability of more affordable housing has resulted in an increasing number of home buyers who commute to the metropolitan employment centers. The portion of Sutter County in the study area is encompassed by the Tisdale Bypass, Sutter Bypass, Sacramento River, and the southern county boundary line. The largest communities within the Sutter County Mid-Valley study area are Robbins (population 400), and Nicolaus (population 100) (Sutter County, 1994).

In order to house the anticipated population which is projected for Sutter County in 2010, Sutter County will need approximately 59,019 housing units if a 4.0 percent vacancy rate is achieved. This figure represents an increase of 34,856 dwelling units over the 1990 census total of 24,163 housing units. Of these new units, 35 percent of them will be in the Yuba City Urban Area, and 56 percent is projected to be in the South County Planning Area. During the current Housing Element until June 30, 1996, it is projected that 7,758 housing units will be constructed in the county. Of this total, 4,616 will be in the unincorporated area. The units in the unincorporated area will be located as follows: Yuba City Urban Area - 1,721 units; South County Planning Area - 2,450 units; and remaining County unincorporated areas - 445 units (Sutter County, 1994).

The remaining rural land in Sutter County is reserved for agricultural uses, although housing is allowed if it is related to agricultural uses (as stated in the Plan section of the Housing Element). The rural, agricultural lands are not considered to be the solution for the county's urban housing needs (Sutter County, 1994).

According to the U.S. Bureau of the Census, the population of Yuba County increased approximately 10 percent from 1970 to 1980. The 1990 census reported that 58,228

people reside in Yuba County, an increase of 16 percent over the 1980 census population figure of 49,733. Wheatland, the largest community in the Yuba County study area, as an estimated population of 48,800. In 1975, a special census was conducted throughout Yuba County. According to the census, 6,244 (37 percent) people resided within the urbanized areas of Linda and Olivehurst. Approximately 11 percent of the population is located in the foothill and mountainous communities of the county. Housing in the Yuba County portion of the project area is concentrated in the Wheatland area. The 1990 census reported 21,245 housing units in the county of which 93 percent were occupied. In contrast, the 1980 census reported 19,093 housing units in the county of which 91.7 percent were occupied. Housing units in the unincorporated areas totaled 16,320 in 1990 and 13,747 in 1980. The 1990 SACOG Housing Module also indicated that 85.5 percent of the housing countywide was 10 or more years old, and 84.9 percent was located within the unincorporated portion of the county.

Population growth in Yolo County has been approximately 24 percent, with the population increasing from 91,788 to 113,374 from 1980 to 1990. Presently 81.9 percent of the County's population lives in urban areas while 18.1 percent resides in rural areas. Population growth in Yolo County since 1970 has been concentrated in the cities of Davis and Woodland. The largest community in the Yolo portion of the project area is Knights Landing with a population of 850 (Yolo County, 1983).

Yolo County single family housing has continued to grow steadily over the past decade despite the fluctuations in housing production occurring as a result of uncertain economic conditions. The role of mobile homes will continue to play an even larger role in meeting housing demands, especially with new legislation permitting such structures in single family residential districts. Total growth in all housing units from 1980 to 1990 was 14 percent. Significant urban redevelopment is proposed for parts of the east Yolo County region, while sprawling urban growth is being limited by careful planning and zoning that effectively allows "fill-in" growth in the urbanized areas of the county. In addition, Yolo County may, in cooperation with the incorporated cities of Yolo County, meet a portion of its goals by providing housing in the unincorporated area.

The population of Placer County in 1990 was 172,796, according to the U.S. Bureau of the Census. The number of people living in Placer County more than tripled in the 30 years between 1960 and 1990, growing at an average annual rate of about 3.8 percent per year. Since 1980, the population has become increasingly concentrated in the incorporated cities.

While 38 percent of the population lived within the incorporated cities in 1980, that percentage increased to 51 percent in 1990. This increase resulted mainly from the incorporation of Loomis in 1984, as well as relatively high growth rates in the cities of Rocklin, Roseville, and Lincoln (Placer County, 1994). The population of Placer County in 1990 was 172,796, according to the U.S. Bureau of the Census (Placer County, 1994). South Placer, the location of the two largest cities in the county, accounted for almost 63 percent of the county's population. The population of the unincorporated area was 117,347 in 1980 and 172,796 in 1990, an estimated increase of 47 percent. South Placer has 37.5 percent of the unincorporated population, and the remaining 11 percent lives in the Lake Tahoe area (Placer County, 1994).

The 1990 census reported 77,879 housing units in Placer County. Only 64,101 of the units were occupied year-round; the remaining 13,778 units (18 percent) are vacant most of the year. The total number of housing units recorded in the incorporated cities was 35,372 and unincorporated areas was 42,507, for a total of 77,879 in all of Placer County. There were 64,101 Placer County households in 1990, resulting in an average household size of 2.69 persons.

During the 1970's, Solano County experienced a building boom. Available, affordable land and proximity to the San Francisco and Sacramento metropolitan areas have made it an attractive location for thousands of new homes, and the population of most cities has increased rapidly. The population of unincorporated areas increased from 16,610 in 1970 to 18,626 in 1986, an increase of 10 percent. The only portion of Solano County in the study area is the area encompassed by the South Fork of Putah Creek and Interstate 80. Single family residences are scattered throughout the greater portion of unincorporated areas. The population and land use summary for Solano County as of January 1994 estimates a population of 354,234 for incorporated cities and 20,689 for unincorporated areas, for a total of 373,923 population census for the county (Solano County, 1994).

Economy. The civilian labor force in the region is within all or portions of the Chico Metropolitan Statistical Area (MSA), the Yuba City MSA, and the Sacramento MSA. A growing number of the Mid-Valley area residents, particularly in Yuba City MSA, commute to other counties, particularly south Placer and Sacramento.

Employment in Sutter County, from its earliest beginnings, has been dominated by agriculture and agriculturally related services and industries. The historical concentration of residents has been in the rural

and unincorporated areas of the county. Current figures show that the majority of the county's population now resides in the urban area; yet agriculture continues to contribute to the economic vitality of the county. Eight of the 23 largest employers in the county as of June 1993 are agricultural processors or agricultural service firms.

The most dominant economic force in Yuba County is agriculture. The gross value of all agricultural production for 1980 was $89,644,600, an increase of $6,472,300 over 1979, $26,558,800 over 1978, and $26,484,100 over 1977. And yet, only a small portion of labor force is in the agriculture industry. Employment figures are compiled on a Yuba-Sutter bi-county basis. According to the information compiled by the State Employment Development Department, public service type employment is the largest group in the labor force in this region. The unemployment rate for the Yuba-Sutter area during 1980 was 12.5 percent. There are approximately 30 major industries located in Yuba County, and many of them are located in the Yuba County Airport Industrial Tract #1. The larger industries include Acme Plastics, All Pure Chemical Company, Coca Cola Bottling Company, Northern California Trucking, United Parcel Service, and others. The per capita personal income in Yuba County has always been lower than the State as a whole. The primary reasons are seasonal employment in the agriculture industry and lower than average earnings. Approximately 70 percent of the households earned less than $10,000 per year, and only 2 percent earned more than $35,000 per year (Yuba County, 1988).

Yolo County's economy is primarily agricultural--with a relatively high number of jobs based on activities relating to the production or processing of farm products. There are a number of other manufacturing industries in the county, however, as well as a large State university, which provide a substantial number of jobs. A significant economic structure has been built up over the years in support of agricultural operations throughout the county. The economic structure includes agricultural equipment manufacturing, repair, and parts service, as well as agricultural product trucking. The Port of Sacramento ships massive amounts of grain and other agricultural products with as many as 175 ships calling and nearly 3 million tons of cargo per year. Financial institutions and a significant proportion of the population are oriented toward agriculture for development and production. A gradual diversification of industry has been experienced in the planned urban areas of the county. More industrial development is contemplated in the Southport and other areas of east Yolo and the industrially designated areas around the four cities of West Sacramento, Woodland, Davis, and Winters.

The portion of Placer County in the project area is located in an unincorporated area along Yankee Slough. Placer County is part of a larger regional economic unit (the Sacramento metropolitan area). Job opportunities for the region are concentrated in the central city (Sacramento), and the people cross county lines commuting from home to work. The 1990 census reported that 57 percent of Placer County's employed residents also work in the county. A large share (34 percent) commute to the city of Sacramento. Some Placer County employed residents commute to jobs in Nevada, El Dorado, Yuba, and Yolo Counties, as well as to more distant job centers such as those in the Bay Area. The State Employment Development Department (EDD) reports total wage and salary employment in Placer County in 1990 as 61,300. Three-quarters of those jobs are in manufacturing, retail trade, services, and government sectors. Self-employed workers are an important component of economic activity in Placer County, accounting for about one-third as many jobs as does wage and salary employment alone. South Placer is characterized by flat, valley terrain, suitable for large-scale, planned business park and industrial development and is virtually indistinguishable from the urbanized development of neighboring Sacramento County. Seventy percent of the jobs in Placer County are located in South Placer. Most of those jobs are concentrated in and near the cities of Roseville and Rocklin, near the centers of population, and in business and industrial parks developed near those communities. There are more jobs in the unincorporated areas of South Placer than in the city of Lincoln, although the estimate for 1990 is quite small compared to the estimates for Rocklin, Roseville, and vicinity (Placer County, 1994).

The portion of Solano County in the project area is located in an unincorporated area along Putah Creek. Much of the economy in the unincorporated area is devoted to agricultural uses, and there is little concentrated development outside incorporated areas except for a few rural residential communities. Other development in the unincorporated area includes Solano Community College near Fairfield, Voice of America, American Telephone and Telegraph, and U.S. Navy transmission facilities near Dixon; and scattered commercial establishments along Interstate Highway 80 (Solano County, 1994).

Environmental Consequences

Purpose

This section analyzes the environmental consequences, or impacts, that are expected to result from implementation of the alternatives for the Mid-Valley Area Levee Reconstruction Project.

Physical Environment

Geology

No Action. The geological conditions are expected to remain the same without the project.

With the Project. No adverse affects are anticipated.

Topography

No Action. The topographical conditions are expected to remain the same without the project.

With the Project. With the construction of seepage/stability berms at Sites 4, 6, 7, 9, 10, 11, 14, 17, 18, 19, and 20 levee slopes may be altered slightly; however, no adverse affects to topography are anticipated.

Soils

No Action. The condition of soils are expected to remain the same without the project.

With the Project. Soil would be removed from the borrow sites for levee construction activities. Soil would also be excavated for ditch relocation. Most of the borrow material consists of sediments which have been transported to and deposited in the bypasses or settling basin. Soil materials at sites proposed for construction have been previously disturbed for the construction of flood control structures. Therefore, no adverse effects are anticipated as a result of the physical working and movement of soils for construction purposes.

One of the proposed project repair alternatives is the application and incorporation of dry lime (approximately 2 to 4 percent) to a depth of 4 feet on the levee crown and landside slope soil to about 10 feet beyond the levee toe, stockpiling the material, mixing it with lime, and recompacting it to an established landside slope. The intent of this application of lime is to provide a protective cap of treated soil that would be resistant to the weathering process by maintaining a fairly constant moisture content in the clay soil blanket. Lime treatment of existing levee material, at Sites 3, 12, 12A, 13, 15A, and 15B (total of 9.96 miles), would change the portions of the levee crown and landside slope soil structure and composition to a more alkaline material.

Prior to construction soil samples would be taken from each site proposed for lime treatment and tested in a soils

laboratory for optimum density, compaction and water content with and without the addition of different concentrations of lime. These tests would determine the percentage of lime, per volume of soil, required stabilize the levees at each site. The optimum percentage of lime added to the levee material is the minimum amount that would lower the plasticity index of the soil below 40 and produce a pH of approximately 12. After the top 4 feet of levee material is excavated, the specified amount of lime would be spread evenly over the surface of the soil to be mixed. After application of the lime, a light application of water would be used to prevent dusting and achieve a good distribution of the lime. The soil/lime material would be blended with a pulverizer to stabilize and compact the mixture. This mixture is then considered sterile due to it's high pH and would not be able to sustain vegetative growth (Conroy, 1995). Once the lime is mixed with the levee soil, hydrated, and compacted properly a strong bond forms between the molecules of the three materials so that the resultant mixture would resist wind dispersion, leaching and levee sloughing from erosion.

Pure lime is a very light substance and stockpiles of lime material are susceptible to wind dispersion and runoff contamination if it is not handled properly. The contractor would be required to implement specific construction practices to avoid or reduce the potential for lime contamination to the project environment. Any stockpiled lime material would be placed on an impervious material, and covered with plastic to prevent offsite movement and contamination. Mixing of levee materials with lime and water would occur on top of the levees, at the levee toe, or in the staging areas.

Direct construction impacts to soils at Sites 3, 12, 12A, 13, 15A, and 15B would result from soil pH and composition changed due to the addition of lime. However, lime is widely used in agricultural areas to raise soil pH as a part of general farming practices. Furthermore, soils in the project area have been previously altered for other farming practices such as the application of pesticides, herbicides and fertilizers.

Air Quality

No Action. Without the project, it is anticipated that air quality in the area would remain the same. Air quality could gradually be reduced as population, construction, and industry in the study area increase. There would be no short-term degradation of air quality due to levee reconstruction.

With the Project. Short-term impacts on air quality are likely. Construction emissions would be short-term during project development. Long-term emissions as a result of

project operations and maintenance would remain the same since these practices are not expected to change in the future. Stabilization of the levee system is expected to restore the level of flood protection currently understood to exist in the project area. It is unlikely that this project would induce additional development in the flood plains. Therefore, no significant increase in air pollution is expected.

Direct construction impacts on air quality would include dust and particulate generation from earthwork activities, lime dust generation, combustion emissions resulting from heavy-duty construction equipment, and airborne slurry particles from the cutoff wall construction alternative. Furthermore, machinery is likely to cause combustion emissions such as nitrous oxide (NO_x), carbon monoxide (CO) and ozone. This short-term increase in particulates and emissions is considered a short-term unavoidable impact that would be controlled by the contractor to comply with local air quality standards.

Analysis of short-term impacts is based on predicted daily emissions associated with levee construction. These emissions are shown below (Corps, 1992). The number and type of equipment used are based on data for emergency levee repairs conducted along the Sacramento River in 1986. Construction emissions would be temporary, of short duration, and limited to a few sites.

Estimated Project Air Pollutant Emissions
(Pounds per Day)

Pollutant	CO	Total Hydrocarbons	NO_x	Reactive Organics	SO_x	Particulate Matter
Emission	355	729	5,975	1,237	191	277

Lime dust generation before and during soil treatment would be controlled by scheduling construction activities during periods of very low air movement, immediately hydrating the lime/soil mixture, and pulverizing the lime/soil mixture to stabilize it so dust is no longer generated when the materials are worked.

Minor, short-term increases in dust and particulates from construction activities are expected. The construction contractor would be required to maintain all construction areas free from dust or other air emissions to the extent possible, that would cause the local standards for air pollution to be exceeded, or would cause a hazard or nuisance to others. In addition, staging areas have been located throughout the project area to minimize disturbance to

residential areas and impacts to air quality. By locating staging areas throughout the project, the number of trips required for construction would be fewer and of shorter duration.

Water Quality

No Action. The water quality of waterways within the project area is expected to remain the same without the project. Temporary decreases in water quality would likely occur in the event of a flood. Turbidity would likely increase, and water could be contaminated by foreign substances entering the floodwaters from a contaminated area during flooding.

With the Project. Two of the proposed levee modification alternatives (construction of a cutoff wall or seepage/stability berm) would require reconstruction on the work waterside toe of the levee at Sites 17 and 18. However, the levees are far enough away from the water (50 feet) that no impacts to water quality are anticipated. Construction activities would be confined to the levee crown or the landside of the levee whenever possible. No waterside staging areas would be used for construction activities. At areas proposed for limited waterside work, possibly Sites 17 & 18, a retaining berm would be constructed around the perimeter to prevent any material from entering the Feather River. No work would be conducted in any body of water. No river water will be used for construction purposes. For the ditch relocation construction alternative at Sites 3, 12, 13, and 15A, new ditches will be excavated and filled with water prior to draining and filling in the existing ditches with excavated materials to maintain water quality. The existing ditch at Sites 5 and 19 would be filled and not immediately replaced by a new ditch. Private landowners would excavate new ditches for irrigation purposes as needed. If water is present in the existing ditches at Sites 5 and 19 it would be drained prior to filling the ditches with excavated materials. No water would be discharged into rivers, bypasses, or channels.

At Sites 3, 12, 12A, 13, 15A, and 15B where lime treatment would be used as a construction alternative the contractor would be required to implement specific construction practices to prevent lime contamination of water resources in the project area. Pure lime is a very light substance and stockpiles of lime material are susceptible to wind dispersion and runoff contamination if it is not handled properly. Any stockpiled lime material would be placed on an impervious material, and covered with plastic to prevent offsite movement and contamination. In addition, the lime materials would be hydrated and mixed properly to prevent wind

dispersion and to convert the mixture to a stabilized state that would be resistant to leaching and erosion.

Section 404(b)(1) of the Clean Water Act was not required for project construction. No such analysis was required because there will be no instream work, limited waterside work with protective structures, and no discharge of materials into waters of the United States.

Biological Environment

Fisheries

No Action. The fish populations of the Sacramento and Feather Rivers, Sutter and Yolo Bypasses, and Knights Landing Ridge Cut are not expected to change significantly as a result of no action. Some fish may be lost temporarily during a flood. Fish may spill into the flood plain and be lost when the floodwaters recede.

With the Project. The majority of the work is proposed for the levee crown, landside levee slope, and toe area. Any waterside work, (possibly Sites 17 & 18 approximately 50 feet from the feather river), would not be done in the water but would be confined to a limited area on the berm adjacent to the waterside levee toe. No shaded riverine aquatic habitat would be adversely affected by the proposed project. Therefore, no adverse effects on fish is expected. No staging areas would be used on the waterside of the levee. Sites 17 and 18 construction activities would be contained by a berm constructed between the work area and the water.

Seasonally used irrigation ditches at Sites 5 and 19 would be eliminated by this project. Irrigation ditches drain during the non-irrigation season and do not provide suitable fish habitat; therefore, no impacts are anticipated to fish. Farmers would cut new irrigation ditches when old ditches are filled when needed.

Vegetation

No Action. No change in the riparian vegetation is expected on lands currently within the project levees. Vegetation of the project levees is expected to be maintained as it is today; therefore, no change is expected on the levees.

The grassland and orchard habitats on the landward side of the levee, and the riparian vegetation on the waterward side of the levee, are not expected to change significantly. Maintenance practices and programs are expected to remain as

they are today. Some existing grassland may be converted to orchard. Most orchards in the project area are young and just entering their prime production period. Older orchards are likely to be replanted. Levee breaks and resultant flooding could destroy and damage vegetation without levee reconstruction and reinforcement of project sites.

With the Project. Project construction would adversely affect vegetation at Sites 1-20. A total of 224.28 acres would be disturbed. Vegetative cover types that would be adversely affected by the project would include 8.24 acres of riparian woodland; 3.22 acres of scrub-shrub; 13.08 acres of emergent marsh; 0.05 acre of permanent wetland; and 199.69 acres of grassland/agriculture. Impacts to grasses on levee slopes and adjacent agricultural lands would be temporary; construction areas would be reseeded so grassland would recover their habitat values within one growing season. At Sites 3, 12, 12A, 13, 15A and 15B where lime treatment would raise the pH of the soil to a sterile state for vegetative growth, 12-15 inches of non-treated soil and fertilizer would be applied and disced on top of the treated materials, to help reestablish grassland habitat. Also, within the grassland/agriculture cover type, a total of 73 individual trees and shrubs would be removed. Since these individual trees are widely scattered along the 18.27 miles of levees which would be repaired, they were counted by reach, but not included as a specific cover type. No woody vegetation losses were identified at construction staging areas or borrow sites since impacts to woody vegetation at these sites could be avoided by fencing or flagging markers prior to construction.

Impacts were evaluated by the FWS using a HEP analysis. The HEP is included in the CAR. The HEP includes surveys of the fish and wildlife habitat that is adversely affected by project construction. Based on the amount and quality of affected habitat, the HEP determines the number of Habitat Units (HU's) that would be affected by a project. Since the HU value takes into account both quality and quantity, it is a more meaningful indicator of the habitat values lost than acreage. Project construction would adversely affect vegetation at 20 worksites. Terrestrial habitat losses at each site, in terms of Average Annual Habitat Units (AAHU's) and lost acres, are presented in **Table 2**, and totals are presented in **Table 3 (FWS, 1995)**. A total of 10.03 AAHU's would be disturbed (2.67 AAHU's on the Sacramento River, 5.05 AAHU's on the Knight's Landing Ridge Cut, 0.18 AAHU on the Yolo Bypass, and 2.13 AAHU's on the Feather River). Vegetative cover types adversely affected by the project would include 0.54 AAHU of emergent marsh, 6.81 AAHU's of riparian woodland, 2.67 AAHU's of scrub-shrub, and 0.01 AAHU of permanent wetland. For acres affected, FWS assumed that the

Corps would construct berms/drains rather than cutoff walls (least impact). No new cover types would be created by project work or associated mitigation measures.

Three borrow sites could be needed to provide the volume of embankment material necessary for levee raising and for the landside toe berms. Borrow site 1, at the Tisdale Bypass, consists of about 20.0 acres of sandy soils and grasses. Borrow site 2, upstream of the Fremont Weir, consists of about 48 acres of various vegetative species including grasses, mint, and wild mustard. Borrow site 3, within the Cache Creek Settling Basin, consists of about 40 acres of a fallow field (thistle) and scattered trees (cottonwoods) (FWS, 1995).

The CAR also describes the types of vegetation that would be affected at each construction site. Specific biological impacts on individual worksites are presented below and are summarized in **Tables 2 and 3** by acre and by AAHU (FWS, 1995).

Wildlife

No Action. Since no significant change in vegetation is anticipated, no significant change in habitat or wildlife values is anticipated with the no action alternative. Population fluctuations of individual species would continue. Levee breaks and resultant flooding could cause loss of wildlife without levee reconstruction and reinforcement of project sites.

Table 2.	Cover-types impacted, acres impacted, total AAHUs lost, and individual trees lost for the Sacramento River Flood Control System Evaluation, Phase III project.			
SITE #	COVER-TYPE IMPACTED	ACRES IMPACTED	TOTAL AAHUs LOST[1]	INDIVIDUAL TREES LOST
1	Grassland/agriculture	0.09	--	0
2	Grassland/agriculture	0.12	--	0
2-1	Grassland/agriculture	0.01	--	0
2-2	Grassland/agriculture	0.01	--	0
2-3	Grassland/agriculture	0.01	--	0
2-4	Grassland/agriculture	0.01	--	0
2-5	Grassland/agriculture	0.01	--	0
2-6	Grassland/agriculture	0.01	--	0
2-7	Grassland/agriculture	0.01	--	0
2-8	Grassland/agriculture	0.01	--	0
2-9	Grassland/agriculture	0.01	--	0
2-10	Grassland/agriculture	0.01	--	0
3	Grassland/agriculture Emergent marsh	14.60 .05 14.65	-- 0	0
4	Grassland/agriculture	14.60	--	7
5	Emergent marsh Grassland/agriculture	0.73 4.41 5.14	0 --	9
6	Grassland/agriculture	12.67	--	0
7	Grassland/agriculture	10.19	--	0
9	Grassland/agriculture	1.93	--	0
10	Grassland/agriculture	1.38	--	33
11	Grassland/agriculture	5.51	--	7
12	Riparian woodland Emergent marsh Grassland/agriculture	5.69 7.39 30.74 43.82	4.69 0.18 -- 4.87	0
12A	Grassland/agriculture	10.33	--	0
13	Emergent marsh Grassland/agriculture	1.15 5.32 6.47	0.18 --	0
14	Grassland/agriculture	10.19	--	0
15A	Emergent marsh Grassland/agriculture	3.62 16.63 20.25	0.18 --	0
15B	Grassland/agriculture	51.24	--	0
17	Riparian woodland Permanent wetland Grassland/agriculture	0.68 0.05 1.84 2.57	0.56 0.01 -- 0.57	1
18	Riparian woodland Grassland/agriculture	1.87 0.70 2.57	1.56 --	3
19	Emergent marsh Grassland/agriculture	0.14 2.61 2.75	0 --	13
20	Scrub-shrub Grassland/agriculture	3.22 4.49 7.71	2.67 --	0
		TOTAL: 224.28	TOTAL: 10.03	TOTAL: 73

[1]No HEP was conducted on grassland/agricultural cover-types, as indicated by the two dashed lines (--).

* Taken from FWS Draft CAR 1995.

Table 3. Summary of cover-types impacted, acres impacted, total AAHUs lost, and individual trees that would be lost from Sacramento River Flood Control System Evaluation, Phase III project.

COVER-TYPES IMPACTED (excludes borrow sites)	TOTAL ACRES IMPACTED	TOTAL AAHUs LOST	INDIVIDUAL TREES LOST
Grassland/agriculture	199.69	--	(from grasslands/ agriculture areas)*
Emergent marsh	13.08	0.54	
Riparian woodland	8.24	6.81	
Scrub-shrub	3.22	2.67	
Permanent wetland	0.05	0.01	
	TOTAL: 224.28	TOTAL: 10.03	TOTAL: 73

* Taken from FWS Draft CAR 1995.

<u>With the Project</u>. The loss of habitat acreage and value associated with construction of the project in cover types other than grassland/agricultural lands would reduce the carrying capacity for wildlife in the affected reaches. All wildlife species displaced by the project are lost since adjacent habitats are assumed to be at carrying capacity. Impact to the grassland/agricultural lands is expected to be temporary, and the habitat would restore itself after construction is completed. No overall reduction in acreage of grassland/agricultural land is expected; therefore, wildlife use of this cover-type would only be temporarily disrupted.

<u>Threatened and Endangered Species</u>

<u>No Action</u>. Since no significant change in vegetation or wildlife resources is anticipated, no significant change in habitat or endangered species values is anticipated with the no action alternative. Population fluctuations of any existing species would continue. Levee breaks and resultant flooding could cause loss of life of threatened and endangered species without levee reconstruction and reinforcement at project sites.

<u>With the Project</u>. A detailed discussion of the impacts of the project on threatened and endangered species is included in Appendix B.

The BDR addresses any potential effects of the proposed project on listed species of concern within the project area. Federally listed species include winter-run chinook salmon, delta smelt, giant garter snake, bald eagle, American peregrine falcon, Aleutian Canada goose, vernal pool tadpole shrimp, valley elderberry longhorn beetle, vernal pool fairy shrimp, Conservancy fairy shrimp, Delta green ground beetle, palmate-bracted bird's-beak, and Solano grass. Proposed Federally listed species include Sacramento splittail, California red-legged frog, Contra Costa goldfields, Colusa grass, and Hartweg's golden sunburst. Forty additional species of concern (candidate and recommended for candidate status) are also described. All of these species were identified in the FWS letter dated April 18, 1995, as possibly occurring within the project area. Federally and State-listed

species include winter-run chinook salmon, delta smelt, giant garter snake, bald eagle, American peregrine falcon, palmate-bracted bird's-beak, and Solano grass. State-listed species include bank swallow, Swainson's hawk, and western yellow billed cuckoo, Colusa grass, and Hartweg's golden sunburst.

The proposed project would not affect any listed or proposed species except the valley elderberry longhorn beetle (Site 12, 12A and 20), the giant garter snake (Sites, 3, 5, 12, 13, 15A, and 19), Swainson's hawk, and possibly the bank swallow. Additional information is summarized in the following paragraphs.

The winter-run chinook salmon does occur in the Sacramento River near the project area. However, since the proposed work is on the levee crowns, landside levee slopes, and levee toe areas in the Sacramento River portion of the project area, no adverse impacts to winter-run chinook salmon would occur as a result of project construction. Waterside work proposed for Sites 17 and 18 would occur approximately fifty feet away from the Feather River. The proposed construction would not include any instream work and work on the waterside of the levees is limited to the waterside toe. Preventative measures would be taken by the contractor to ensure that soils and construction materials do not enter the river. Therefore, the winter-run chinook salmon would not likely be affected by the proposed project.

The delta smelt is not likely to occur in the Sacramento River near the proposed construction sites because the project area is significantly upstream from the highest current and historic sightings (Corps, BDR, 1995). The proposed project would not include any instream work and work on the waterside of the levees (Sites 17 and 18) is limited to the waterside toe. Therefore, the delta smelt would not be adversely affected by the proposed project.

The giant garter snake can be found in sloughs, ponds, small lakes, low gradient streams, and other waterways such as irrigation and drainage canals, and may potentially occur within the proposed project area. About 13.08 acres of irrigation ditches, some of which contain emergent marsh cover type, would be adversely affected by the project due to ditch relocation activities. Preproject surveys would be conducted at Sites 3, 5, 12, 13, 15A and 19 to determine if the giant garter snake is present within the project area. If surveys determine that the giant garter snake is present, specific mitigation requirements would be implemented to avoid or reduce the potential for adverse affects to this species.

The bald eagle is rarely found within the project area. Although nesting is not expected to occur, it is possible that

eagles would forage, perch, or roost in the area. However, if eagles do use the area, they are probably transient visitors and not likely to be adversely affected. Thus, this species would not be significantly affected by the project.

The American peregrine falcon is rarely found within the project area. Suitable nesting habitat does not appear to exist within the area proposed for construction. If peregrine falcons do use the project area, they are probably highly mobile fall and winter transients and are not likely to be affected. Therefore, the peregrine falcon would not be affected by the project.

The Aleutian Canada goose migrates from the Aleutian Islands to winter in the Central Valley of California. Preferred habitats include fresh emergent wetlands, croplands, and pastures, all of which are found in the proposed project area. Canada geese migrating through the project area would probably be reluctant to feed or rest in areas immediately adjacent to construction areas. However, because of the abundance of wintering habitat within the project area, temporary disturbance of goose habitat due to construction activities would be less than significant.

The vernal pool tadpole shrimp, vernal pool fairy shrimp, Conservancy fairy shrimp, and delta green ground beetle are found only in vernal and playa pool habitat, which is not present in or near the project impact area. Since no suitable habitat for the invertebrates would be affected by the proposed project, no adverse affects are anticipated.

Habitat for the valley elderberry longhorn beetle exists along the river throughout much of the project area. Surveys conducted by Corps biologists in July of 1994 revealed that 12 clumps containing a total of 1,333 stems greater than 1 inch in diameter may be affected by the proposed project at Sites 12, 12A, and 20. Four of the 12 clumps (33 percent) had stems with emergence holes. Prior to construction, elderberry bushes would be flagged and protected or properly relocated to a mitigation site. The Corps is requesting Section 7 consultation with the FWS since it is possible that the shrubs and the beetle could be directly affected by levee repair activities. Specific mitigation plans would be implemented to reduce the adverse affects to a less than significant level.

No suitable habitat for palmate-bracted bird's beak or Solano grass exists in the project area so no adverse impacts are anticipated. Solano grass, associated with lake bed soils and vernal pools, would not likely be affected since no vernal pools are found in the project area. Palmate-bracted bird's beak is found in association with valley and foothill grassland in seasonally flooded saline-alkali soils of lowland

flats and plains. Since grasslands would be affected by the project, this endangered plant could possibly be affected. However, it is unlikely that palmate-bracted bird's beak would be found in the project area because this species has very specific growing conditions which are extremely unlikely to be present on maintained levees or agricultural fields. In addition, known populations of palmate-bracted bird's beak are well identified and monitored. Therefore, palmate-bracted bird's beak would not be adversely affected by the proposed project.

Swainson's hawk is known to nest and forage within the project area. Numerous historical and current nest sites are documented within the general geographic area encompassed by the project. Swainson's hawks are vulnerable to disturbance when establishing nesting territories, and when incubating and rearing young. Nesting Swainson's hawks could be affected by this project. DFG generally identifies areas within one-half mile of a Swainson's hawk nest site as a sensitivity zone. Where nests are located on the opposite side of the river, or where there is sufficient screening to protect the nest area, the radius of sensitivity zones may be reduced in size through coordination with DFG. Preproject surveys would be conducted for this species. If no nests or Swainson's hawk territories are found within one-half mile of the project area, then construction would be allowed during their nesting season. If nests are located within the project area DFG would be consulted and specific guidelines would be implemented to avoid or reduce impacts to this species.

Bank swallows are colonial nesters. Preferred nesting habitat are vertical banks found in association with riparian areas. Most of California's remaining population nest along the upper Sacramento River, with a few colonies found along the Feather River. The proposed reconstruction work is not expected to adversely affect the bank swallow because of it's limited range of occurrence and due to the lack of suitable habitat in the project impact area. In addition, no instream work and only limited waterside work near riparian areas are proposed as part of this project. Preproject surveys would be conducted by a qualified biologist in areas where waterside work is proposed (Sites 17 & 18), or where suitable nesting habitat may be adjacent to a construction zone to ensure no adverse affects to this species.

Western yellow billed cuckoo is migratory and winters in South America and nests primarily in the Sacramento Valley. Preferred nesting habitat is large stands of deciduous riparian forest, preferably with a high willow composition. This project would not adversely affect this the Western yellow billed cuckoo because of it's extreme rarity, and it's need for large riparian stands for nesting habitat,.

None of the proposed species are likely to occur in the project area or be affected by the project. The Sacramento splittail does occur in the Sacramento River near the project sites, but this habitat would be avoided during construction. All populations of the California red-legged frog on the valley floor are thought to have been eliminated so no impacts to this species are anticipated. Contra Costa goldfields and Colusa grass are both limited to vernal pool habitat, which is not present in the project impact area. The closest known extant occurrence of Hartweg's golden sunburst is more than 60 miles south of the project and no suitable habitat for this species exists within the project impact area. Analysis of project impacts to the other 40 species of concern are included in Appendix B.

Surveys would be conducted to determine if the Federally listed threatened valley elderberry longhorn beetle and giant garter snake, and the State listed threatened Swainson's hawk and bank swallow would be adversely affected by the proposed project. The Corps would request Section 7 consultation with the FWS if it is determined that the proposed project would adversely affect any threatened, endangered, or proposed Federally listed species. In addition, the Reclamation Board and the Corps would consult with the DFG if it is determined that any State listed species would be adversely affected by the proposed project.

Cultural Resources

No Action. Conditions of cultural resources sites within the proposed project area would not be disturbed by levee reconstruction activities and are expected to remain the same. Levee failure and resultant flooding could damage archeological sites in the project area.

With the Project. Site CA-Sut-11 lies within Site 19. Project related construction at this location includes creation of a seepage/stability berm on the land side of the existing levee. Impacts to the archeological site would principally result from the movement of heavy equipment across the site. On the other hand, placement of material on top of the archeological site to create the land side berm would actually protect the resource.

Site AC-S-2 lies within site 12A. Project-related construction at this location includes lime treatment of the land side slope and crown. Construction at site 12A would require excavation over a portion of the site to a depth of approximately 4 feet, which would disturb and remove cultural material. Movement of heavy equipment across the site are apt to adversely affect the site. Similar to site CA-Sut-11,

placement of materials over undisturbed portions of the archeological site would serve to protect these cultural values.

Recreational Resources

__No Action__. The condition of recreational resources is expected to remain the same without the project.

__With the Project__. Most of the land in the proposed for levee reconstruction is privately owned farmland and access to resources such as the Sacramento and Feather Rivers, Sutter and Yolo Bypasses and Knight's Landing Ridge Cut for recreation is very limited. Incidental recreational use of the Sacramento and Feather Rivers and other watercourses may be disrupted temporarily during construction. These disruptions would cease once construction is completed. Since most of the recreational resources are between the levees, it is likely that flooding would have similar effects on recreational resources with or without the project.

Esthetic Resources

__No Action__. Without the project, esthetic conditions would likely remain the same as they are now. However, a flood would be more likely to occur without the project. If floodwaters breach the levee system, it is possible that the force of the floodwaters would degrade natural areas, destroy urban areas, and scatter debris, lowering the visual quality of the area. These impacts would probably be temporary. However, if vegetation is destroyed either by the force of floodwaters or through inundation of the root zone, recovery would take more time.

__With the Project__. The visual character of areas adjacent to the construction sites may be changed temporarily. It is anticipated that once revegetation takes place, grassy areas would appear similar to the current conditions within 1 growing season. Riparian scrub-shrub and emergent marsh vegetation removed as a result of project construction would take years to reestablish. Scrub-shrub riparian and emergent marsh habitat that is replaced should return to their pre-project visual values within 3 to 10 years.

Hazardous, Toxic, and Radiological Waste

__No Action__. Without the project, any existing HTRW would remain unless the State forces remediation of these sites. Existing conditions may continue or the situation may become worse if contaminated soil or ground water migrates through resource areas with high concentrations of petroleum hydrocarbons or agricultural chemicals. Contamination of

ground water and soils could easily result from flooding or continued farming practices such as irrigation and chemical application of pesticides.

With the Project. There is no known contamination in proposed project sites or within the right-of-way of proposed project sites. No specific or unusual HTRW concerns have been identified that would significantly affect the proposed project. The Corps would develop a contingency plan to identify a responsible agency and outline a course of action in the event that HTRW sites are uncovered during construction.

The Corps recently developed agency policy in response to CERCLA, which holds certain categories of individuals strictly liable for all clean up and response costs of any hazardous substances regulated under CERCLA. This policy states that between the Government and the local sponsor, it would generally be the local sponsor's responsibility to assure clean up and pay all response costs for any HTRW sites located on a Civil Works project. However, if HTRW material exists within the construction area, the Federal Government would determine as soon as possible the extent and nature of the contaminated material prior to construction. If already in construction, the Federal Government and local sponsor shall decide whether to continue construction, terminate construction or, if possible, redesign the project. In any event, should the Federal Government and local sponsor decide to proceed or continue with construction after considering any liability that may arise under CERCLA, the local sponsor shall be responsible for any studies, investigations, clean up and response costs. In addition, the local sponsor shall operate, maintain, repair, replace, and rehabilitate the project in a manner so that liability would not arise under CERCLA.

Lime materials would demonstrate hazardous waste characteristics at a pH of 12.5 that can harm human tissue and aquatic life and may react dangerously with other wastes. The pH of water solution (25 C) with lime is 12.4. Pure lime is a skin irritant and inhalation of lime dust should also be avoided.

Socioeconomics

Land Use Impacts

No Action.

- Direct Impacts

Under this alternative, the Federal government would not participate in levee reconstruction measures. An estimated

106,387 acres would be subject to flooding in Yolo and Sutter Counties (location of proposed reconstruction sites 1 through 20) with levee failure during a flood event (Corps, 1995). A majority of this land is in agricultural use. Although economic losses could be high, long-term changes in agricultural land use would not be anticipated as a direct result of flooding. Impacts on urbanized areas would be more significant and potentially long-term. In areas where flood damages are severe, agricultural lands could be converted to less intensive uses.

- Indirect Impacts

Development in the study area has been based on the assumption that the levee system provides the design level of flood protection. Recent geotechnical investigations revealed that the system conveys a lower level of flood protection than assumed. This new knowledge could cause currently approved plans and those under study to be curtailed or eliminated. As a result, future development could be substantially reducing incorporated or unincorporated areas such as Knights Landing, Robbins, and Nicolaus. Areas previously affected by flooding may not be redeveloped.

With the Project.

- Direct Impacts

Levee reconstruction would permanently disrupt use of locally important farmland. The total loss of these farmlands from this project is less than 0.1 percent of the total farmlands in Sutter County, and approximately 1 percent of the total farmlands in Yolo County. Since the acreage of affected agricultural land is small, none of the proposed construction activities would result in significant adverse effects to agriculture. Table 3 shows the estimated widths of potential construction impacts for each site.

Permanent and temporary levee easements would require about 224.28 acres in the two-county area where the proposed levee reconstruction sites are located (Yolo and Sutter Counties) (FWS, 1995). The majority of this land is agricultural with a limited amount of commercial and residential acreage. The commitments of the limited acreage required for permanent and temporary easements are less than significant. Construction would generate noise, dust, and potential traffic disruptions which may adversely affect adjacent land uses. However, these impacts are short-term and less than significant.

Table 4. Estimated Widths of Potential Construction Impacts

Site #	Existing Permanent Easements (linear feet)			New Permanent Easements (linear feet)	New Temporary Easements (linear feet)
1. Sutter Bypass	0	0	0	30	20
2. Sutter Bypass	0	0	0	30	2
2-1. Sutter Bypass	0	0	0	30	20
2-2. Sutter Bypass	0	0	0	30	20
2-3. Sutter Bypass	0	0	0	30	20
2-4. Sutter Bypass	0	0	0	30	20
2-5. Sutter Bypass	0	0	0	30	20
2-6. Sutter Bypass	0	0	0	30	20
2-7. Sutter Bypass	0	0	0	30	20
2-8. Sutter Bypass	0	0	0	30	20
2-9. Sutter Bypass	0	0	0	30	20
2-10. Sutter Bypass	0	0	0	30	20
3. Sutter Bypass	20	75	10	0	30
4. Sacramento River	0	50	0	50	20
5. Sacramento River	0	20	0	50	0
6. Sacramento River	0	50	0	50	20
7. Sacramento River	0	50	0	50	20
8. Sacramento River (deleted)	0	0	0	0	0
9. Sacramento River	0	50	0	50	20
10. Sacramento River	0	50	0	50	20
11. Sacramento River	0	50	0	50	20
12. Knights Landing Ridge Cut, east levee (lower reach) (upper reach)	20	60	10	76	20
12A. Knights Landing Ridge Cut	20	60	10	0	30
13. Knights Landing Ridge Cut	20	35	10	76	20
14. Sacramento River	0	50	0	50	20
15A. Yolo Bypass	20	60	10	50	20
15B. Yolo Bypass	20	60	10	0	20
16. Feather River (deleted)	0	0	0	0	0
17. Feather River	25	50	40	50	20 20*
18. Feather River	25	50	40	50	20 20
19. Feather River	25	50	0	50	20
20. Sacramento River	25	50	0	50	20

* Assume landside unless otherwise noted.
Maximum easement required.
Waterside of levee.

• Indirect Impacts

The proposed project would not increase the flood protection level over the level originally authorized. The approved and proposed development in the study area assumes that this level of protection is already provided. Therefore, the project is not expected to induce land use changes, but it would allow implementation of current land use plans which permit the continuing conversion of agricultural and open space lands to more intensive uses.

Population.

No Action.

• Direct Impacts

Should flooding be severe, the population may decrease in the most significantly affected areas. Certainly there would be a short-term displacement of population. Long-term displacement could result if the perception of future flood threat is high and/or if flood proofing is not feasible in areas subject to the greater flood depths. Because of the short warning period and the potential for deep flooding, a levee failure near populated areas would probably result in significant loss of life, potentially in excess of 100 people (Corps, 1992).

• Indirect Impacts

Should currently adopted plans and plans under study be modified due to a reassessment of existing flood protection, future population growth could be reduced. In the areas most affected by deep flooding, this reduction in future population growth could substantially reduce both the projected population numbers as well as the density of the population. The impact on regional growth is difficult to determine. Growth may be simply shifted to other areas outside the flood plain, but remain within the region.

With the Project.

• Direct Impacts

The majority of construction employees are projected to be local residents; therefore, short-term or long-term increases in local population would not occur. The Corps' real estate appraisal does not indicate any temporary or permanent relocations resulting from the levee work. Therefore, there would be no adverse impacts on local population. Nuisance impacts associated with construction would be short-term and less than significant.

* Indirect Impacts

The project is not expected to induce growth. The purpose of the project is to restore existing levees to a previous level of flood protection. The project would not increase the level of flood protection within the project area.

<u>Housing</u>

<u>No Action</u>.

* Direct Impacts

The Corps' Economics Section reports that flooding within the Mid-Valley project area could affect as many as 1,256 housing units (Corps, 1995). Impacts would vary from short-term and minor to long-term and significant. Generally, impacts on housing would be most severe in the more densely populated areas of Knights Landing, Nicolaus, and Robbins. Impacts could include loss of housing units, extensive housing damage, and loss of housing value and marketability.

* Indirect Impacts

Future plans for housing development could be limited or substantially modified in the most flood prone areas. Limitation of housing in flood prone areas could adversely affect future housing supply and affordability. It is often not economically feasible to flood proof residential areas, especially where flood depths approach 10 feet.

<u>With the Project</u>.

* Direct Impacts

The Corps' real estate reports indicate no relocation of housing units for required levee work and easements. Construction workers would be primarily local and would not affect local housing demand. The project would have no adverse impacts on housing (Corps, 1992).

* Indirect Impacts

The proposed project would not induce additional demand for housing. Impacts on existing and future housing supply would be beneficial. No adverse impacts on housing are anticipated.

Economy.

No Action.

- Direct Impacts

Flooding due to levee failure could result in severe economic losses, particularly in urbanized areas. Agricultural losses may be high, but would be generally short-term. These losses, in turn, could adversely affect employment levels.

- Indirect Impacts

Many of the land use plans for the study area assume large-scale economic development and economic redevelopment in older areas. It is more economically feasible to provide flood proofing to commercial and industrial areas than to residential development where higher flood depths occur. However, inadequate flood protection may discourage economic expansion in the most flood prone areas, encourage a shift in economic development to other areas, and discourage redevelopment in areas now considered economically marginal. To the extent economic development is slowed or curtailed, employment levels could also decline.

With the Project.

- Direct Impacts

A survey of prior Corps projects indicates that the majority of the Corps national construction work force is composed of local workers. The local labor force is defined as those workers who will not change their residences to assume employment. The labor force within the Sacramento metropolitan statistical area provides a diverse and ample work force for the required construction. Estimates of project employment assume that 35 percent of construction costs are allocated to labor. When cost estimates are refined, the actual number of workers and distribution by employment category would be determined.

- Indirect Impacts

The project would restore prior levels of flood protection, as previously authorized, to economic centers now primarily located in the Knights Landing, Nicolaus, and Robbins areas. It will also allow implementation of economic development plans for the study area. In general, economic conditions would be generally as described under the Existing Environment.

Cumulative Impacts

- Direct Impacts

Regulations under the National Environmental Policy Act define a cumulative impact as ". . . the impact on the environment which results from the incremental impacts of the project when added to other past, present, and future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor collectively significant actions taken over a period of time" (40 CFR 15081.7). The regulations require a "discussion of project impacts that, when combined with the impacts of other projects, result in significant cumulative effects" (40 CFR 1508.25).

In this case, cumulative impacts were evaluated by listing past, present, and future projects which, in conjunction with this current project, may produce significant cumulative impacts along the Sacramento River. These projects, their impacts, and mitigation are briefly described below.

<u>Past Projects</u>. The following projects have been completed, including mitigation activities:

<u>Sacramento River Flood Control Project.</u> This project was authorized in 1917 and consists of over 1,000 miles of levees, overflow weirs, pumping plants, and bypass channels that protect communities and agricultural lands in the Sacramento Valley and Sacramento-San Joaquin Delta. Riparian vegetation was directly affected by this project and largely unmitigated because at that time no provisions in the project authorizations required mitigation. Riparian vegetation was also indirectly affected as private development increased due to improved flood control. Most of these impacts were also unmitigated because State and local laws at the time did not require mitigation. However, socioeconomic benefits have been positive due to greatly reduced flood damages.

Various studies of the historical and present extent of riparian vegetation along the Sacramento River and tributaries indicate that less than 2 to 3 percent of historical woody riparian habitat area remains. It is assumed that cumulative effects on wildlife, fisheries, and plant species dependent on riparian habitats (terrestrial and aquatic) are directly correlated with the reductions in natural riverbank and riparian vegetation. Given the importance and value of this vegetation to wildlife and fisheries and the reduction to date, any further reduction must be considered a significant adverse affect (Corps, 1992).

Ongoing Projects. These projects are currently under construction, and/or mitigation activities are in progress:

West Sacramento Project. This project involves: repair of the south levee of the Sacramento Bypass and the east levee of the Yolo Bypass for a total of approximately 5 miles of levee repair. These project repairs have a relatively insignificant environmental impact. All of the work proposed in this project involves repair and reconstruction work. This project includes mitigation which reduces any environmental impacts to less than significant. A feasibility report and final Environmental Impact Statement/Environmental Impact Report has been prepared for this project. A design memorandum and supplemental EA/IS have been approved, and plans and specifications are currently being prepared. Construction is scheduled to begin in Fiscal Year 1995.

Sacramento Urban Area Levee Reconstruction Project. This is the first phase of the Sacramento River Flood Control System Evaluation, and most of the construction has been completed. The levees have been restored to their original design elevation; therefore, no indirect impacts due to increased development are expected. Construction was done on the landward side of the levees to minimize environmental impacts. Impacts to upland/riparian vegetation and open water/emergent marsh from construction activities have been fully mitigated for through the acquisition and development of a 160-acre mitigation site consisting of these two habitat types. The Old Sacramento Floodwall is being added to phase one, and is the only uncompleted component in the this phase. Repairs include anchoring and stabilizing the existing floodwall. Any environmental impacts are expected to be insignificant because of the highly developed nature of the area.

Future Projects. Reasonably foreseeable future projects are discussed below:

Sacramento River Flood Control System Evaluation, Phase II. Phase II of the Sacramento River Flood Control System Evaluation would reconstruct levees in the Yuba City and Marysville area. Levees would be restored along the Feather, Bear and Yuba rivers, and along the Sutter Bypass between Wadsworth Canal and the Feather River. This project is expected to begin construction during the 1995 construction season. Approximately 70 acres of a 200 acre site owned by the Reclamation Board would be developed as a mitigation site for this project.

Sacramento River Flood Control System Evaluation, Phases IV - V. These studies will evaluate the integrity of, and the level of flood protection provided by, the existing

Sacramento River Flood Control Project levees; determine whether or not the levees currently function as designed; and, if remedial work is needed, determine the Federal interest in proceeding with construction. The proposed work does not enhance the original design levels and consequently is not expected to induce growth. Most, if not all, work will be on the crown and/or landward side of existing levees. Specific impacts and associated mitigation will be addressed in the environmental document for each phase. All impacts will be fully mitigated.

Yuba River Basin Investigation. The reconnaissance study was completed in 1990 and determined that one or more alternatives for a flood control project appear feasible. Of the proposed alternatives, levee raising would have the least adverse environmental impact. Therefore, feasibility studies will investigate levee raising alternatives along the Feather and Yuba Rivers. A feasibility study assessing the environmental impacts of the project is currently being prepared.

Summary of Direct Cumulative Impacts. Every effort would be made to avoid adverse environmental impacts for Phase III of the Sacramento River Flood Control System Evaluation, particularly to woody riparian habitat which has been significantly affected. No riparian vegetation on the waterside of the levee would be adversely affected. Any adverse environmental impacts that cannot be avoided would be mitigated below the level of significance, and there would be no long-term net loss of riparian, emergent marsh, or scrub-shrub habitat values in the project area. Therefore, Phase III would not add any further impacts to the cumulative impacts described above.

- Indirect Impacts

Cumulative indirect impacts resulting from the proposed project in combination with past, ongoing, and future projects are not likely to adversely affect land use and air quality. The proposed project would stabilize levees in the Mid-Valley area to ensure the level of protection they are capable of providing at their present height. The project would not increase the level of flood protection that the levees were originally authorized by Congress to provide. Rather, the project would restore the authorized level of flood protection originally envisioned by Congress. Land use decisions in the area have been made based on the assumption that the authorized level of flood protection was being provided by the system. Therefore, the Mid-valley project combined with the action of past, ongoing and future projects, would not significantly affect land use decisions in the project area.

Since only minor short-term impacts to air quality are expected in the Mid-valley project area, no cumulative indirect impacts to air quality are expected to result from construction of the proposed project in combination with the past, ongoing, and future projects. Air quality impacts are discussed further in the Air Quality section.

Growth-Inducing Impacts

No Action.

Approved development in the project area has been based on the assumption that the levee system provides the previously authorized design level of protection. This project is intended to restore existing levees to a previously authorized level of flood protection. There would be no increase in the level of flood protection as a result of this project. Therefore, growth in the area is not expected to change as a direct result of levee reconstruction.

The Sacramento River Flood Control System Evaluation has identified deficiencies in the structural integrity of the levees, indicating that the level of flood protection provided by project levees in the study area is lower than previously thought. Without the project, local agencies responsible for land use planning would be obliged to acknowledge the lower level of protection. This could be a constraint on the planned growth in the study area.

With the Project. The proposed project would not increase flood protection levels over those levels originally authorized. With the project, portions of the study area (sites 1 through 20) would be repaired, thereby restoring the level of flood protection to that which was previously authorized.

Mitigation

Physical Environment

Geology. No mitigation would be required.

Topography. No mitigation would be required.

Soils. One of the repair alternatives for this project involves the incorporation of dry lime into the soil. Incorporation of lime would change the soil composition and structure of levee materials to a more alkaline state at Sites 3, 12, 12A, 13, 15A, and 15B. However, lime is commonly used in soil treatment agricultural practices in addition to pesticides, fertilizers and herbicides; therefore, no mitigation for soils would be required. Stockpiled lime

material would be stored only on an impervious surface and would be covered with plastic to prevent offsite movement.

<u>Air Quality</u>. Impacts to air quality are related to short-term emissions from levee construction. To avoid these impacts, construction vehicles should be fitted with emission reduction equipment. Water trucks should be used regularly to reduce dust and particulate generation at construction sites and along non-paved roads. Dust generated through the incorporation of dry lime into levee soils, as proposed in the lime treatment alternative, would be controlled by the contractor through the scheduling of work on during periods of low air movement; hydrating the lime/soil mixture, and immediately pulverizing the mixture to stabilize the materials so the mixture would no longer generate dust when worked. A alternative to levee crown and slope stabilization through topical application would be lime injection in the interior of the levee. This alternative requires less manipulation of lime materials outside of the levees. The contractor would be required to take measures to prevent any construction activities from adversely affecting air quality standards in the project area. Lime materials would be stockpiled on a impervious material and covered with plastic to prevent leaching, erosion, and dispersion. Since the area is rural and farming activities generate comparable levels of dust, local air quality is not expected to be significantly adversely affected by construction activities. Therefore, no mitigation would be required.

<u>Water Quality</u>. At Sites 3, 12, 12A, 13, 15A, and 15B where lime treatment would be used, lime/soil mixtures would be hydrated according to laboratory standards so that the lime/soil molecules would bind properly to prevent leaching or erosion of lime materials into water resources. In addition, lime treatment activities would be limited to periods of low air movement to prevent the generation and dispersion of lime dust into water resources. Furthermore, water would be applied to the soil/lime mixture to assist in dust control, mixing and compaction of the materials to an appropriate state. Lime materials would be stockpiled on a impervious material and covered with plastic to prevent dispersion or leaching. A alternative to levee crown and slope stabilization through topical application would be lime injection in the interior of the levee. This alternative requires less manipulation of lime materials outside of the levees. The contractor would be required to prevent any construction activities from adversely affecting water resources in the project area. Therefore, no mitigation would be required.

Biological Environment

Fisheries. No mitigation would be required.

Vegetation and Wildlife. Mitigation for the unavoidable loss of habitat values associated with scrub-shrub, wetland, emergent marsh, and riparian vegetation would be provided by reestablishing native vegetation in designated areas to replace habitat for wildlife in the affected area. Mitigation commitments (see Environmental Commitments) would be included in the plans and specifications for construction of the project.

A HEP analysis was completed by the FWS. This HEP was based on a worst-case analysis of construction impacts and indicates that 29.66 acres of mitigation is needed to compensate for project impacts. In addition, 365 trees would need to be planted, and 199.69 acres of grassland would need to be reseeded. **Table 5** shows compensation needs by site. **Table 6** gives a summary of cover types affected, acres affected, total AAHU's gained, acres needed for compensation, and number of trees required to be planted for compensation.

This 29.66 acres required for mitigation does not include impacts to emergent marsh which would be self mitigating once it is reestablished in the new irrigation ditches. Individual trees would be planted at the mitigation site. Additional acreage would be required for mitigation for impacts to the VELB. This is discussed in the following Threatened and Endangered Species section.

The topical lime treatment construction alternative proposed for Sites 3, 12, 12A, 13, 15, 15A, and 15B, would render the top 4 feet of treated levee material sterile due to it's high pH and would not be able to sustain vegetative growth (Conroy, 1995). To assist in the reestablishment of vegetation in the areas proposed for lime treatment, that mainly consist of grasses and forbs that are burned once a year as part of levee maintenance practices, 12 to 15 inches of untreated topsoil would be replaced with a fertilizer application uniformly distributed over the surface and worked into the soil by light discing to assist in reestablishment of grasses. After fertilizing, grass seed would be spread over all disturbed areas. At sites where lime treatment would be used, the soil/lime material would be blended with a pulverizer to stabilize and compact the mixture to prevent wind dispersion, leaching and erosion of treated levee material into any other existing vegetation.

Pure lime is a very light substance and stockpiles of lime material are susceptible to wind dispersion and runoff

contamination if it is not handled properly. The contractor would be required to implement specific construction practices to avoid or reduce the potential for lime contamination to the project environment. Any stockpiled lime material would be placed on an impervious material, and covered with plastic to prevent offsite movement and contamination.

Mitigation Location. Three potential mitigation sites were identified by FWS in the CAR. Mitigation Site 1 (60.0 acres) is located in Sutter Bypass near the confluence of the Feather and Sacramento Rivers near the Sacramento Slough. The site is composed of fallow fields containing weeds and is surrounded by riparian forest. FWS prefers Mitigation Site 1 due to its location, access, and management potential (Plate 5). Mitigation Site 2 (70.0 acres) is located in the Sutter Bypass along the Sacramento River between River Mile 84.0 and the East Canal just north of Gray's Bend. This site is currently farmed for safflower (Plates 6 and 7). Mitigation Site 3 (17.0 acres) is located in the Sutter Bypass south of the Sacramento Slough along the East Canal. This site is located near Sacramento River Mile 83.0 and currently supports a jojoba crop (Plate 8). Plate 9 shows all three potential mitigation sites.

These sites were recommended by FWS as typical examples of acceptable mitigation scenarios in the area (FWS, 1995). The acquisition of lands for mitigation has become quite difficult because of future maintenance responsibilities and few willing sellers. The selection of mitigation lands will depend on the availability of suitable land at the time of acquisition. Although Mitigation Site 1 may not be acquired, the reader can assume it is a hypothetical site containing the elements the FWS would recommend for compensation. Final selection would require approval of FWS (FWS, 1995). FWS has described a total of 147 acres of suggested sites from which the compensation could be implemented. Additional acreage may be acquired for plantings if deemed necessary for compensation.

Planting. Once a mitigation site has been selected, planting can begin. The following is a brief discussion of mitigation planting measures necessary to compensate for losses of scrub-shrub, riparian woodland, emergent marsh, permanent wetland, and grassland/orchard cover types (and trees and shrubs growing on the levees) associated with the project. The Corps would request mitigation planting proposals from private contractors. The accepted plan would be circulated to resource agencies for review and comment.

a. Soil testing. Prior to plant installation, soil testing would be completed and analyzed for soil deficiencies

by the contractor. Testing would be done to identify soil characteristics such as texture, structure, and pH balance. Tests would also identify organic matter in the soil and nutrient deficiencies that need to be corrected. All deficiencies that would retard the growth of the plant would be evaluated and corrected during or prior to plant installation.

b. Site analysis. Prior to planting, a thorough site analysis would be performed. Factors such as hydrology, soil profile as it relates to water holding capacity, whether a salinity, alkalinity, or other chemical peculiarity exists in the soil, and ground-water depth would be examined to determine the appropriateness of plantings on the mitigation sites.

c. Plant material acquisition. The contractor would secure the appropriate number of required plants. Plant materials would be collected and propagated for a period of 6 to 12 months preceding plant installation. Native plant species would be used exclusively in this design. Where possible, cuttings, acorns, and seeds from plants near the mitigation sites would be used for propagation.

d. Irrigation. The plants selected for compensation are somewhat drought tolerant to very drought tolerant, assuming ground-water supplies are accessible. On the driest sites, it may be necessary to extend the length of time that irrigation is required to ensure successful establishment of plantings.

e. Diversity. Plantings would be interspersed as much as possible to maximize diversity.

Table 5. Compensation needs for the proposed worksites for the Sacramento River Flood Control System Evaluation, Phase III project.

SITE #	COVER-TYPE IMPACTED	COMPENSATION ACREAGE	TOTAL AAHUs GAINED	NO. OF TREES TO PLANT
1	Grassland/agriculture	0	--	0
2	Grassland/agriculture	0	--	0
2-1	Grassland/agriculture	0	--	0
2-2	Grassland/agriculture	0	--	0
2-3	Grassland/agriculture	0	--	0
2-4	Grassland/agriculture	0	--	0
2-5	Grassland/agriculture	0	--	0
2-6	Grassland/agriculture	0	--	0
2-7	Grassland/agriculture	0	--	0
2-8	Grassland/agriculture	0	--	0
2-9	Grassland/agriculture	0	--	0
2-10	Grassland/agriculture	0	--	0
3	Emergent marsh Grassland/agriculture	0.05 0	4.33 --	0
4	Grassland/agriculture	0	--	35
5, 19	Emergent marsh Grassland/agriculture	0.87 0	2.60 --	45
6	Grassland/agriculture	0	--	0
7	Grassland/agriculture	0	--	0
9	Grassland/agriculture	0	--	0
10	Grassland/agriculture	0	--	165
11	Grassland/agriculture	0	--	35
12 12, 13, 15A 12	Riparian woodland Emergent marsh Grassland/agriculture	8.08 12.36 0 20.44	6.97 23.37 -- 30.34	0
12A	Grassland/agriculture	0	--	0
13	Grassland/agriculture	0	--	0
14	Grassland/agriculture	0	--	0
15A	Grassland/agriculture	0	--	0
15B	Grassland/agriculture	0	--	0
17	Riparian woodland Permanent wetland Grassland/agriculture	0.97 0.05 0 0.98	1.16 0.44 -- 1.60	5
18	Riparian woodland Grassland/agriculture	2.69 0	2.32 --	15
19	Grassland/agriculture	0	--	65
20	Scrub-scrub Grassland/agriculture	4.59 0	3.49 --	0
		TOTAL: 29.66	TOTAL: 44.68	TOTAL: 365

* Taken from FWS Draft CAR 1995.

Table 6. Summary of cover-types impacted, acres impacted, total AAHUs gained, acres needed for compensation, and number of trees required to be planted for compensation for the Sacramento River Flood Control System Evaluation, Phase III project.

COVER-TYPE IMPACTED	TOTAL ACRES IMPACTED	TOTAL ACRES NEEDED FOR COMPENSATION	TOTAL AAHUs GAINED	NUMBER OF TREES TO PLANT
Grassland/agriculture	199.69	--	--	(from grassland/agricultural areas)
Emergent marsh	13.08	13.28	30.30	
Riparian woodland	8.24	11.74	10.45	
Scrub-shrub	3.22	4.59	3.49	
Permanent wetland	0.05	0.05	0.44	
TOTAL	224.28	29.66	44.68	365

* Taken from FWS Draft CAR 1995.

f. Brush. Any brush that is cleared on, or adjacent to, the mitigation site should be used on-site to provide wildlife cover. An optimum brush pile is 12 feet wide, 12 feet long, and 4 feet high.

FWS recommendations for mitigation plantings are discussed below and included in the CAR.

Riparian Woodland. The project would affect 5.69 acres of riparian woodland at Site 12, 0.68 acre at Site 17, and 1.87 acres at Site 18. Results showed that the impacts would be fully compensated by replanting 11.74 acres of riparian vegetation at a suitable compensation site. Development of the mitigation site would involve the planting of various riparian tree species including Fremont cottonwoods, valley oaks, and willows. The species mix and density would be sufficient to establish 60 to 80 percent canopy cover by the end of the 52-year period of analysis. Plantings can be obtained from local stock through cuttings and seeds, and grown at a local commercial nursery. All plantings would require watering, weed control, protection from predation, and replacement of dead or dying plantings. Watering and maintenance would be required until the plants are self-sufficient and capable of self-regeneration (generally 3 years).

Estimated costs to replace riparian vegetation were $25,000 per acre in 1993, excluding land acquisition and maintenance costs. Irrigation (drip system) would be required for a minimum of at least 3 years, or until the plantings are well established and self-sustaining. Any dead or dying trees and shrubs would be replaced and maintained until well established.

Scrub-shrub. The project would affect 3.22 acres of scrub-shrub habitat at Site 20. HEP results show that project impacts would be fully compensated by establishing 4.59 acres of scrub-shrub habitat at the mitigation site.

Development of the site would include the planting of various riparian scrub-shrub species including willows and box

elders. The species would be planted at a density which would establish 60 to 80 percent canopy cover within 10 years. Costs have not yet been determined but would be expected to be somewhat less than those stated for the riparian forest cover type.

Emergent marsh. The project would affect 0.05 acre at Site 3, 12.16 acres at Sites 12, 13, and 15A and 0.87 acre at Sites 5 and 19. The management plan would provide a net increase of 4.33 AAHU's for Site 3, 23.37 AAHU's for Sites 12, 13, and 15A, and 2.60 AAHU's for Sites 5 and 19. For Site 3, 0.05 acre would be needed for compensation, and for sites 12, 13, and 15A, 12.36 acres would be needed for compensation. For Sites 5 and 19, 0.87 acre would be needed for compensation (Table 5). Although Site 5 was evaluated as emergent marsh cover type, it contains a concrete-lined channel and would be replaced at a ratio of 1:1. No AAHU's were lost at Site 5, which also contain no emergent marsh cover type.

In accordance with the FWS mitigation policies in Region 1, there can be "no net loss of in-kind habitat value or acreage" (whichever is greater in acreage). For Site 3, the 0.05 acre required for full compensation would be replaced by relocating the ditch and slightly expanding the acreage suitable for wetland vegetation establishment. The same work would occur at sites 5 and 19. For sites 12, 13, and 15A, 12.36 acres required for full compensation would be replaced at a ratio of 1:1.

The FWS recommends enhancement whenever possible. The relocated drainage ditches would be enhanced to provide better habitat values than are currently present at the sites. FWS has recommended that the emergent marsh cover type be improved for wildlife use. However, because the purpose of this project is flood control, the Corps is not funded to provide enhancement features.

Permanent Wetland. The project would affect 0.05 acre at Site 17. The management plan would provide a net increase of 0.44 AAHU. For this site, 0.05 acre would be needed for compensation so that a 1:1 compensation ratio would be achieved (Table 5). In accordance with the FWS's mitigation policies in Region 1, there can be "no net loss of in-kind habitat value or acreage" (whichever is greater in acreage).

Grassland/agriculture. Any loss of grassland habitat values due to project construction would be offset by seeding the disturbed areas and newly created berms with native grasses and forbs. Seeding would be conducted just prior to the rainy season. This would allow sufficient germination and establishment of these species. The estimated cost to reseed would be about $700 per acre (1993 calculation).

Individual trees and shrubs. The removal of any individual native trees and shrubs in the grassland/agricultural areas along the landside toe of the levee and adjacent areas would require replacement. The trees provide important perching sites for raptors such as Swainson's and red-tailed hawks. They also provide cover for passerine birds, and valley oak and black walnut trees provide food for species such as the western gray squirrel. The shrubs provide cover for small mammals such as the black-tailed jackrabbit and California vole. Because of their value to various wildlife species in the proposed project area, mature trees and shrubs would be replaced at a ratio of at least 5:1. All plantings would require watering and maintenance for a minimum of 3 years or until the plantings well established and capable of surviving on their own. The most efficient watering method is the drip system. The loss of 73 scattered individual trees would be mitigated by planting 365 trees. All plantings would require watering, weeding, and protection from predation. Tree species that could be affected by the project are found in Table 7. Costs have not yet been determined. Not all of the 73 individual trees would be removed. The exact number of replacement trees planted would vary depending on actual impacts at the time of construction.

Threatened and Endangered Species. The giant garter snake may be affected by project construction. Surveys would be conducted by a qualified biologist for the giant garter snake at all sites with proposed ditch filling and/or relocation work. Since the giant garter snake is a State- and Federally listed threatened species, formal consultation would be pursued with FWS and DFG, by the Corps and the Reclamation Board, relative to impacts on the giant garter snake if preproject surveys indicate the presence of this species. FWS and DFG guidelines would be followed to avoid and mitigate for adverse affects to this species, including scheduling construction between May 1 and October 1 in areas where the snake may be present, and constructing and filling the new ditch with water prior to draining and filling the old ditch. In areas where adverse effects are significant and cannot be avoided, a cutoff wall through the levee crown could be constructed instead of filling and/or relocating the irrigation ditch. Therefore, adverse affects to the giant garter snake resulting from project construction would be avoided or mitigated to a less than significant level.

The loss of VELB habitat would be mitigated by replacing removed elderberry shrubs in accordance with FWS guidelines. All elderberry shrubs found at Sites 12, 12A, and 20 would be avoided and flagged prior to construction. The Corps would compensate for losses to the elderberry shrubs at Sites 12,

12A, and 20 (if they cannot be avoided) according to the most recent FWS compensation guidelines for the VELB. This compensation would be coordinated with the staff of the Endangered Species section of the FWS if it is determined that the VELB inhabits the elderberry stems. Construction of the project could remove 1,333 stems out of 12 clumps of elderberry bushes that are greater than or equal to 1 inch in diameter. Four of the 12 clumps (33 percent) have stems with emergence holes. In accordance with FWS mitigation guidelines (FWS 1994), the existing shrubs, if adversely affected, would be transplanted, and 3,999 new elderberry plants would be planted at the mitigation site. Mitigation would be coordinated with the FWS throughout construction (Corps, 1994).

The FWS recommends that 26.99 acres be planted as mitigation for adverse impacts to fish and wildlife resources. Some of this acreage would be credited as mitigation for the loss of VELB habitat. These calculations are based on FWS policy for determining how wildlife mitigation credits can be applied toward VELB mitigation (Corps, 1992). FWS allows credit for wildlife mitigation to be applied towards VELB mitigation. The credit is determined by calculating the percentage of affected habitat that is covered by elderberry shrubs. This percentage is multiplied by the acreage of compensation for the affected habitat. The resulting figure is the acreage that can be applied towards VELB mitigation.

Because of the interval of time between the preparation of this document and the onset of construction activities, site conditions could change to where nesting bank swallows could be affected by this project. Where waterside work is proposed, or where suitable nesting habitat is immediately adjacent to the construction area, preproject surveys would be conducted to determine if this species is present. If this species is present DFG would be consulted and construction deferred at that site until nesting activities for this species are complete.

Nesting Swainson's hawks could be affected by the project. The DFG generally identifies the area within one-half mile of a Swainson's hawk nest site as a sensitivity zone. Where nests are located on the opposite side of the river, or where there is sufficient screening to protect the nest area, the radius of sensitivity zones may be reduced in size through coordination with DFG. If no nests or Swainson's hawk territories are found within one-half mile of the project area, then construction would be allowed during their nesting season. To avoid affecting Swainson's hawks, construction activities would be scheduled outside of the breeding and nesting season to the greatest extent possible, which is generally March 1 to August 15. If construction activities

are necessary within that time, then the following restrictions would apply:

- No project construction would take place between March 1 and May 1, when Swainson's hawks are returning from their winter migration and establishing nest territories. Construction during this time could deter arriving hawks from using potential nest sites.

- In cooperation with the DFG, the area within a one-half mile radius of the project site would be surveyed during this time (March 1 to May 1) to determine if Swainson's hawks have established a nest territory which could be affected by proposed project activities.

- If no nests are located during this time, the project may proceed and would not cause adverse impacts to this species.

- If a nest is located within the one-half mile radius, DFG would be consulted to determine:

a. If the location of the nest (such as on the opposite side of the river), or the presence of vegetative or other types of screening is sufficient to warrant reduction of the sensitivity zones. Nesting activity on the opposite bank has generally resulted in a one-quarter mile sensitivity zone.

b. If the proposed work activity is likely to cause disturbance to the nest. Some types of construction activities, such as surveying or hand work, would probably not cause a disturbance. Even more intensive activities may be able to proceed if the nest is monitored and activity is stopped if the birds show signs of stress.

The Corps would consult with FWS and the Reclamation Board would consult with DFG to avoid adverse impacts to threatened and endangered species, in accordance with the State and Federal endangered species laws.

Recreation

No mitigation would be required.

Esthetics

No mitigation would be required.

Cultural Resources

Neither site CA-Sut-11 nor site AC-S-2 have been evaluated for eligibility for listing on the National Register of Historic Places. Such evaluation would be necessary to determine the need for mitigative measures for these sites. There is a high degree of probability that site CA-Sut-11 would be determined eligible, given Heizer's statement to the effect that this mound site is key to Sacramento archeology. A limiting factor in this regard could be site integrity, in view of the likelihood of extensive and severe site disturbance since 1934.

Site AC-S-2, on the other hand, is probably not eligible for listing on the National Register. This site is described as a surface distribution of farming and ranching equipment and domestic debris dating to the first half of the 20th century, which, in and of itself, is unremarkable. If archival research fails to place this resource within a framework of personages or events which establish its significance, this site is unlikely to meet the minimum criteria or listing.

For those sites evaluated and determined eligible for listing on the National Register, avoidance is the preferred treatment. If avoidance is not feasible, mitigation would be accomplished by a program of data recovery through scientific excavation, archival research, and recordation. Potential impacts to site CA-Sut-11 appear to be only slight to moderate, and the degree and extent of mitigation measures would be determined accordingly. A very limited program of cultural resources data recovery, if any, are likely to be required for this site. Prior to construction the project site would be evaluated further. Test borings would be made in an attempt to identify the boundaries of the archeological site. At the time of construction either a Native American representative or a trained archeologist would monitor the site during earth moving activities incase additional artifacts are uncovered during construction activities.

In the event that human skeletal remains of Native American origin are discovered during construction activities, the statutory requirements set forth in the Native American Graves Protection and Repatriation Act of 1990 would be adhered to.

Hazardous, Toxic, and Radiological Waste.

No HTRW sources are currently known at project sites therefore, no mitigation would be required. Lime treatment of levees would be carefully monitored by the contractor to keep lime/soil pH below 12.5. All construction workers would be required to wear masks or air filtering devices to avoid lime dust inhalation. In addition, goggles, gloves and full-body

clothing should be worn to prevent skin contact with lime materials. Lime materials would be stockpiled on impervious material with a plastic cover to prevent wind dispersion, leaching and erosion. The lime/soil mixture when hydrated and compacting properly would result in a stabile mixture that resists erosion.

Socioeconomic.

No mitigation would be required.

Population. No mitigation would be required

Housing. No mitigation would be required.

Economy. No mitigation would be required.

Cumulative Impacts.

No mitigation would be required.

Growth Inducing Impacts.

The purpose of the project is to restore existing levees to a previous level of flood protection. The project will not increase the level of flood protection within the project area.

The decision of whether or not to develop in the 100-year flood plain is the responsibility of the individual cities and counties. Prior to development, the agencies responsible for land use decisions must prepare environmental documents for the proposed projects. The Corps and the Reclamation Board have no general responsibility for land use decisions. Therefore, no mitigation would be required.

Coordination and Public Involvement

Required Coordination

The information presented in this document has been coordinated with other Federal, State, and local agencies. Coordination to date includes:

National Marine Fisheries Service	Endangered Species Act
U.S. Fish and Wildlife Service	Fish and Wildlife Coordination Act Endangered Species Act
U.S. Environmental Protection Agency	National Environmental Protection Act Clean Water Act
California Department of Fish and Game	California Environmental Quality Act California Endangered Species Act
California State Historic Preservation Office	National Historic Preservation Act - Section 106
Regional Water Quality Control Board	Clean Water Act, Sec 404 (b)(1), 401 Certification

Discussions and site visits were conducted with the staff of the Corps, Reclamation Board, FWS, DFG, State Historic Preservation Office, and National Marine Fisheries Service to evaluate potential mitigation sites, potential project mitigation sites, and potential project impacts.

Public Involvement Process.

This section discusses the public's involvement in the preparation of the programmatic EIS/EIR for the Sacramento River Flood Control System Evaluation, Phases II - V, and specifically, the draft EA/IS for Phase III, Mid-Valley Area. This section also discusses issues and concerns raised by the public regarding the project.

A public comment period for Phases II - V was initiated with the publication of a notice of intent in the February 1, 1990, Federal Register.

Several issues were identified in response to the notice of intent. These issues included impacts of the reconstruction work on downstream flood elevations, erosion, and water supply; impacts of construction activities on noise, dust, and local road systems; potential for increased mosquito habitat production and associated risk of human disease; and impacts to vegetation, fish and wildlife resources, and threatened and endangered species.

The Reclamation Board also sponsored four environmental scoping meetings for Phases II - V to provide information to the public and solicit input. The meetings were held in Marysville, Rio Vista, Colusa, and Woodland on September 25, October 10, October 24, and November 1, 1991, respectively. Public concerns in Marysville involved open space, integrity of the watershed, agriculture, interim flooding, the Yuba goldfields, and Cherokee Canal. Comments in Colusa addressed mitigation, project costs, mosquito control, cumulative impacts, and levee maintenance. Issues raised in Woodland involved mitigation, levee maintenance, interagency conflicts, and local participation. Specific comments can be found in the programmatic EIS/EIR for the Sacramento River Flood Control System Evaluation, Phases II - V.

This draft EA/IS would be provided to concerned agencies, organizations and individuals known to have an interest in this project, and a notice of availability for the draft EA/IS would be mailed to members of the public. A 30 day period would be allowed for comments on the draft EA/IS. This document would be circulated separately by the Corps and the Reclamation Board. Comment letters received on the draft EA/Is would be incorporated as appropriate. Responses to comments received on the draft EA/Is would be included as an Appendix to the final EA/IS.

Environmental Commitments

Levee restoration would require construction activities along both the waterward and landward sides of the levees. However, construction would be primarily along the landward side of the levee. As a result, impacts to environmental resources would be minimized since the more valuable habitat and wildlife resources are on the waterward side of the levees. At sites 17 and 18 where waterside work is identified, the levee is set back about 50 feet from the water, also minimizing impacts to valuable-habitat.

Although impacts have been minimized through selection of construction alternatives, some degree of impact is unavoidable. These impacts would affect primarily vegetation and wildlife. The project would remove 224.28 acres of habitat, including 199.69 acres of grassland/ agriculture

(primarily temporary construction impacts), 13.08 acres of emergent marsh, 3.22 acres of scrub-shrub, 0.05 acre of permanent wetland, and 8.24 acres of riparian woodland. In addition 73 individual trees may be removed from grassland/agricultural areas. FWS completed a HEP analysis and determined that about 29.66 acres of mitigation is required to compensate for project impacts.

Short-term, construction related increases in noise levels, traffic, and dust would be expected as well as short-term degradation of the esthetic appeal of the affected viewsheds. No appreciable impacts to fisheries, water quality, or aquatic resources are expected from implementation of any of the alternatives. The majority of construction activities would be on the landside of the project levees or through the levee crown. Only two waterside construction sites (sites 17 and 18) would be necessary to construct the levee improvements. There would be no waterside staging areas.

The following environmental commitments have been made for this project.

A. Preconstruction.

(1) If possible, avoid all elderberry shrubs found at Sites 12, 12A, and 20 by flagging each shrub prior to construction. If they cannot be avoided, then gather cuttings from elderberry shrubs in the area and begin propagation.

(2) Conduct preproject surveys for Swainson's hawk, giant garter snake, and bank swallow in accordance with DFG and FWS regulations and guidelines.

(3) Acquire 26.66 acres of land for the mitigation of project impacts. Some of this acreage would be used for impacts to elderberry shrubs, but the majority would be used for wildlife mitigation. Additional acreage may be acquired (40 to 80 acres) to plant elderberry bushes and individual trees. Begin propagation of species needed for riparian mitigation plantings.

(4) Mark and fence all elderberry shrubs. Shrubs are not to be removed until the fall or winter when they are dormant and can be safely transplanted to the mitigation site.

(5) Preserve and protect scattered trees at all sites, including staging and borrow sites. The construction contractor will be required to flag and/or fence and avoid any woody vegetation that may be on site. Fencing will be field inspected by DFG and FWS prior to construction. All contractors and crew would be given verbal and written

instructions to avoid these areas and made aware of the significant values of these areas to wildlife. In the event that individual trees must be removed, they would be replaced in accordance with FWS guidelines. These trees would be planted at the offsite mitigation area and would be maintained in accordance with the rest of the mitigation area.

(6) Begin propagation of species needed for riparian mitigation plantings.

B. Construction

(1) A revegetation contract would be awarded to a contractor for riparian woodland, shrub-scrub, and permanent wetland mitigation. Plant trees at the mitigation site to compensate for the scattered trees that would be lost at Sites 4, 5, 10, 11, 17, 18, and 19 if they cannot be protected. Revegetation would be completed concurrent with, or prior to, completion of levee reconstruction.

(2) Emergent marsh would be mitigated on-site through ditch relocations. This portion of the mitigation area would be completed by the construction contractor. The design for the emergent marsh area would be coordinated with the appropriate resource agencies. New ditches would be created and filled with water prior to draining and filling old ditches.

(3) Transplant elderberry shrubs to the mitigation area. The riparian vegetation contractor would be responsible for transplanting these shrubs.

(4) Continue surveying and monitoring all Swainson's hawks nests in the project area from January 1 until August 15 before and during construction. Construction activities would be conducted in accordance with DFG guidelines.

C. Post-Construction

(1) After construction, the construction contractor would reseed all disturbed sites, including levee slopes, borrow areas, and staging areas, with a native plant seed mixture as specified below. Seeding would be installed between September 1 and December 1 following the completion of construction activities. Long-term maintenance of these reseeded areas would not be required.

Type of Seed	lbs. per acre
Zorro Annual Fescue	

Vulpia myuros	15
California Brome *Bromus carinatus*	5
Creeping Wildrye *Elymus triticoides*	5
Meadow Barley *Hordeum brachyantherum*	5
Total lbs. Seed per Acre	30

Mitigation Monitoring

(1) The mitigation contractor would monitor mitigation areas for 3 years after installation of mitigation plantings. All plantings would receive watering, weed control, protection from predation, and replacement of dead and dying trees during the establishment period. Watering and maintenance would be required for a period of 3 years or until the plants are self-sufficient and capable of self-regeneration. Monitoring during this period should be coordinated with FWS and DFG. The FWS recommends a 20-year monitoring period beyond the establishment period to determine the long-term success of the plantings and the overall mitigation effort. The FWS also recommends monitoring on a fixed schedule, such as every year for the first 5 years of the 20-year period and then every 5 years. During the monitoring period, if revegetation efforts are determined to be unsuccessful in meeting criteria established for the site, corrective action would be required until the revegetation goal is met. Annual progress reports would be submitted by the local non-Federal sponsor to the Corps, FWS, and DFG for each of the first 5 years of the monitoring period and then every 5 years.

(2) The Project's non-Federal sponsor would monitor all mitigation areas annually for the life of the project beginning at the end of the establishment period (year 4). Annual documentation would be prepared which identifies the condition of the mitigation area for the first 5 years, and every 5 years after that. Any losses or damage to trees planted for mitigation, and caused by non-natural causes would be replaced or restored to a 75 percent survival rate for the first 3 years, and a 50 percent survival rate after 5 years, in accordance with the original mitigation planting. The Reclamation Board would transfer all or part of this responsibility to the non-Federal sponsor.

(3) The construction contractor would monitor and guarantee the survival of all grass-seeded areas for 6 months.

Successful seeding efforts would result in at least 50 percent cover of the seeded site or 50 percent germination and survival of planted seeds. Seeded areas which fail to germinate or are otherwise damaged may be replaced until March 1. Damage which occurs after this date must be replaced the following fall between September 1 and December 1 in accordance with the original seeding plan.

List of Preparers

Name/ Expertise	Experience	Role in Preparation
Lee Foster Archaeologist	3 years engineering and planning studies, Corps of Engineers	Cultural resources
Craig Gaines Civil Engineer	8 years engineering and planning studies, Corps of Engineers; 13 years private consultant	Report review
Debbie Giglio Biological Sciences Environmental Manager	3 years planning studies, Corps of Engineers; 1 year Biologist, Agricultural Research Service	Report preparation and research
David Gundlach Civil Engineer	22 years, engineering and planning studies, Corps of Engineers	Report Review
Wendy Halverson Environmental Specialist IV	14 years, DWR and the Reclamation Board	Report preparation and review
Paul Hsia Technical Manager	6 years engineering studies, Corps of Engineers; 14 years Tennessee Valley Authority; 2 years private consultant	Report review
Phil Lee Project Manager	20 years construction, planning, and engineering studies Corps of Engineers	Report review
Mark Pelz Biological Sciences Environmental Manager	1.5 years planning studies, Corps of Engineers	Biological Data Report preparation

Susan Ramos Chief, Environmental Planning Section	5 years planning studies, Corps of Engineers; 5 years, Bureau of Reclamation; 4 years, Environmental Protection Agency	Report review
Lynne Stevenson Technical Writer/Editor	9 years planning studies, Corps of Engineers; 10 years professional librarian	Report organization and review

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Sacramento River Flood Control System Evaluation

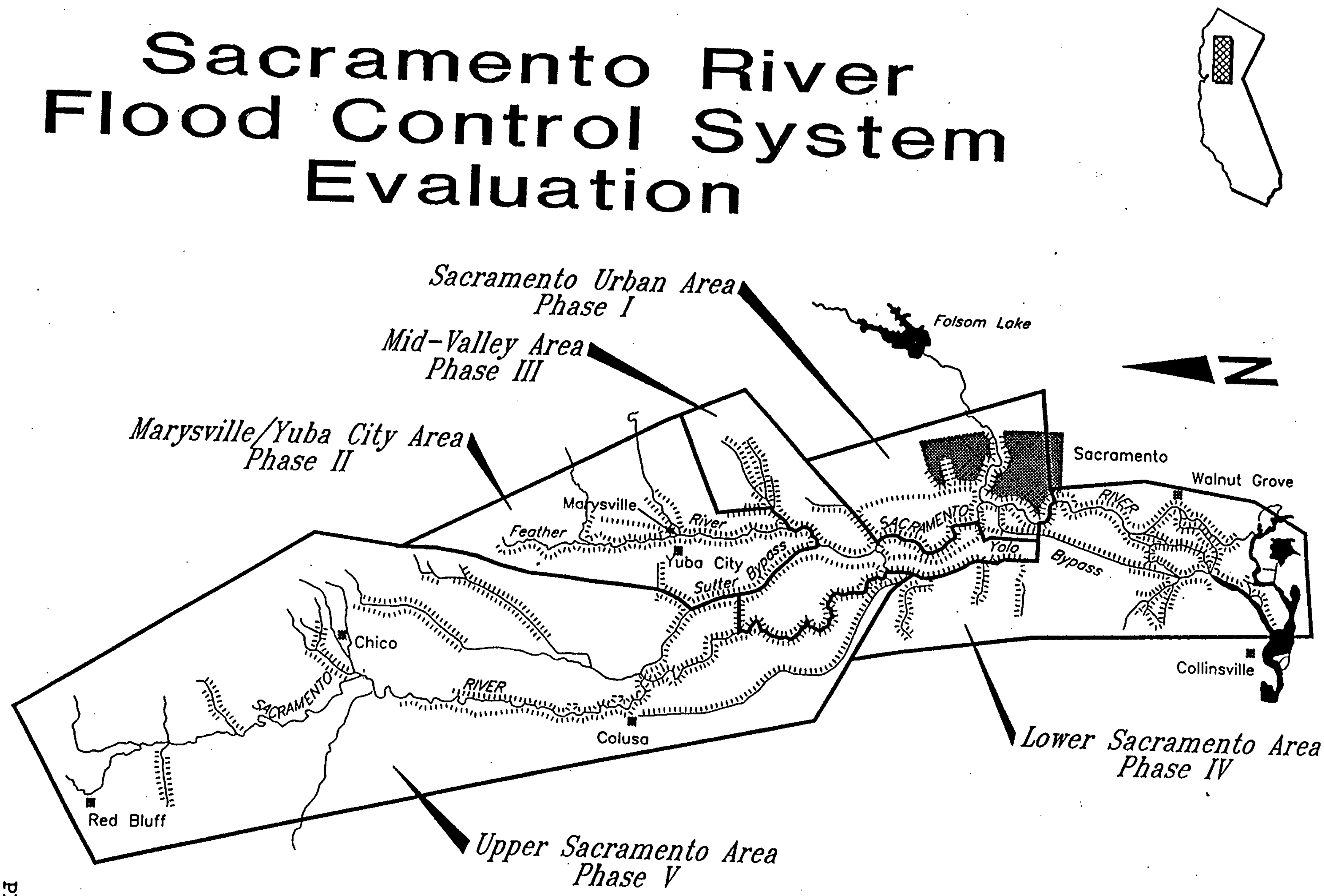


PLATE 1

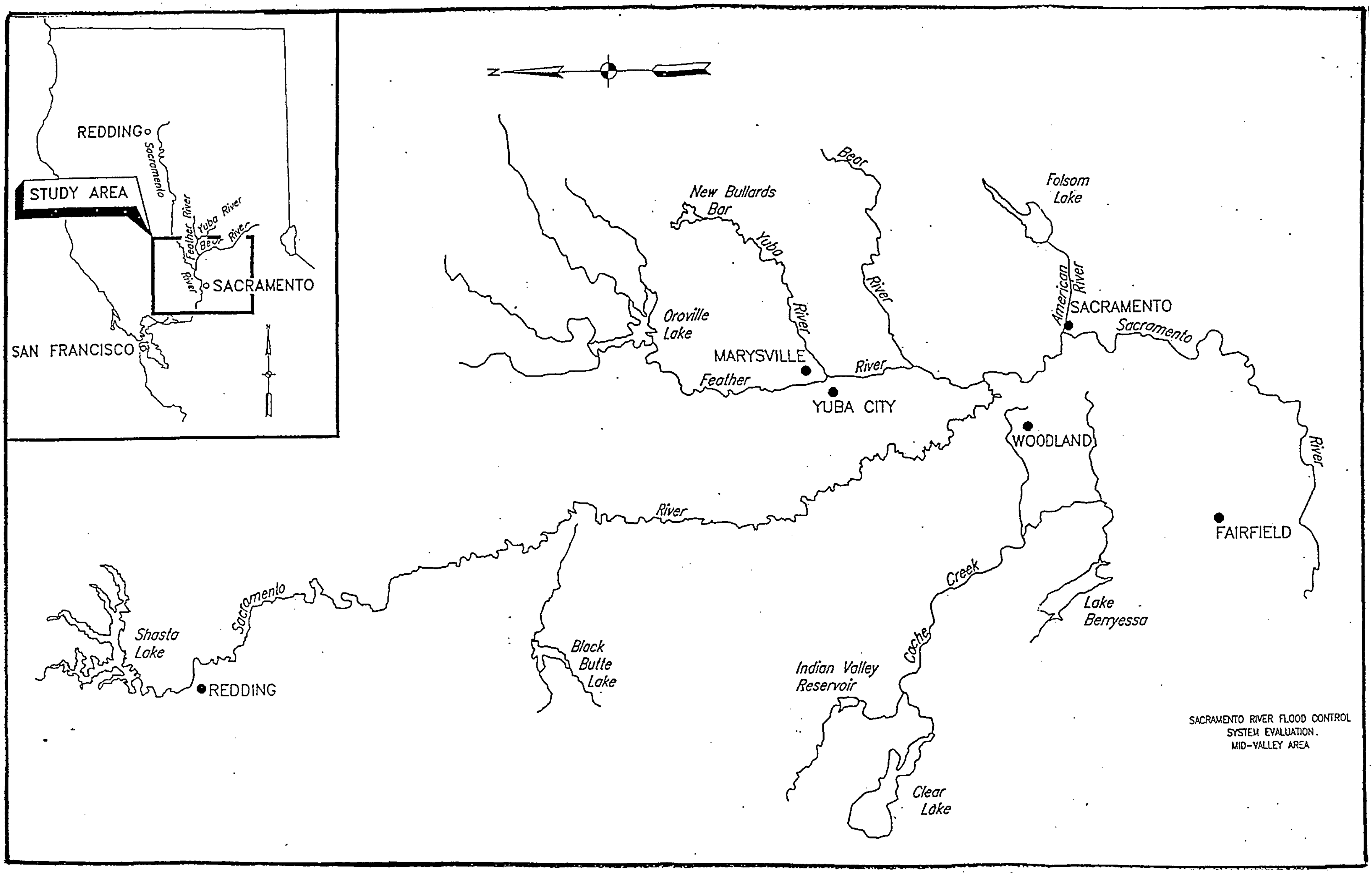
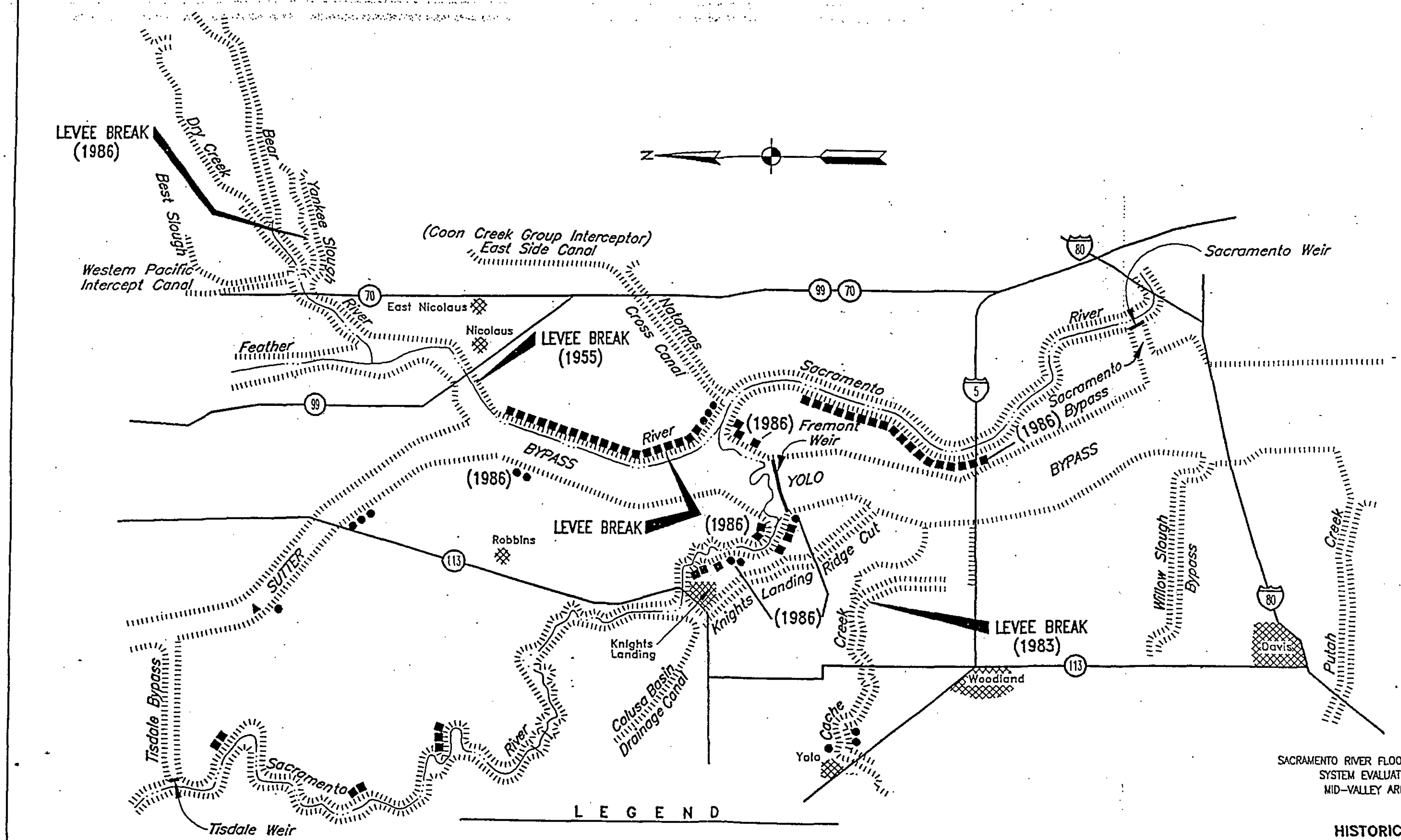


PLATE 2 General map of the Sacramento River Flood Control System Evaluation, Phase III project area (Source: USACE 1991)



L E G E N D

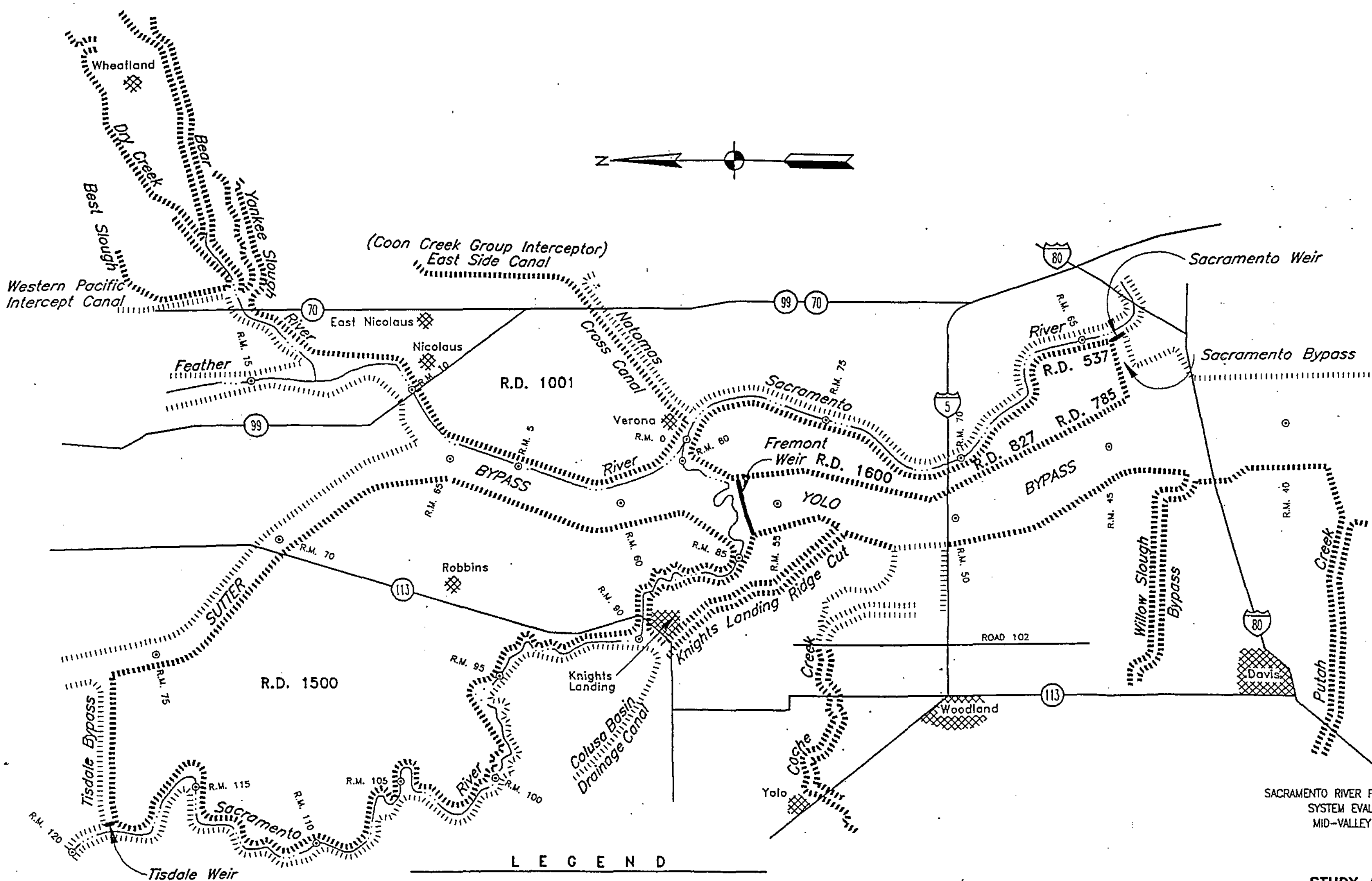
●●●●●●●●	BOILS
▲▲▲▲▲▲▲▲	SINKHOLES
■■■■■■■■	SEEPAGE
(1986)	YEAR OF OCCURRENCE (IF KNOWN)

SACRAMENTO RIVER FLOOD CONTROL
SYSTEM EVALUATION
MID-VALLEY AREA

HISTORIC LEVEE EMBANKMENT PROBLEM AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
MAY 1990

PLATE 3



L E G E N D

EXTENT OF LEVEE EVALUATION

LEVEES NOT EVALUATED

⊙ R.M. 60 CHANNEL OR RIVER MILES

SACRAMENTO RIVER FLOOD CONTROL
SYSTEM EVALUATION
MID-VALLEY AREA

STUDY AREA

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
MAY 1990

PLATE 4

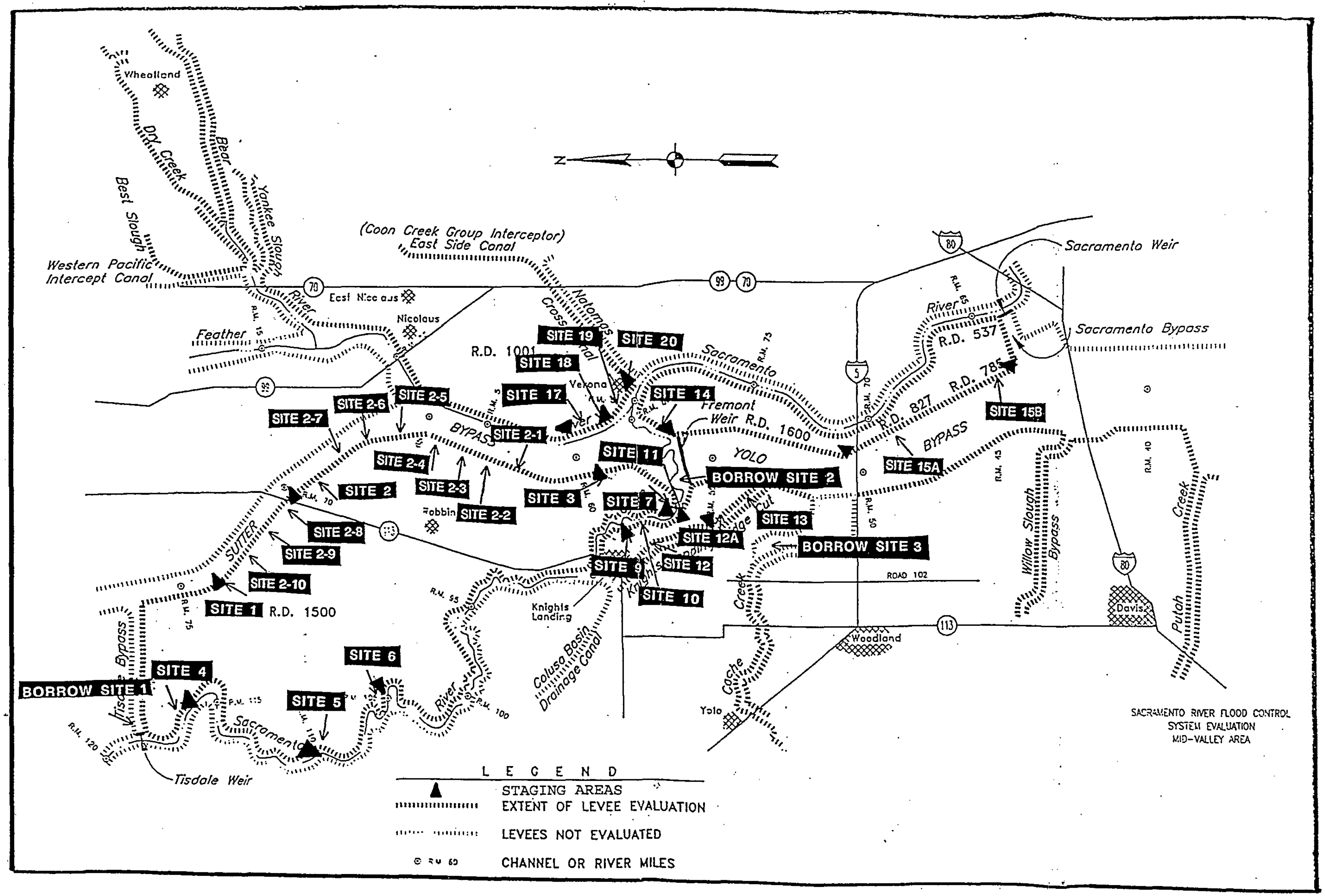


PLATE 5 General site locations of the proposed remedial repairs and borrow sites for the Sacramento River Flood Control System Evaluation, Phase III project (USACE 1991).

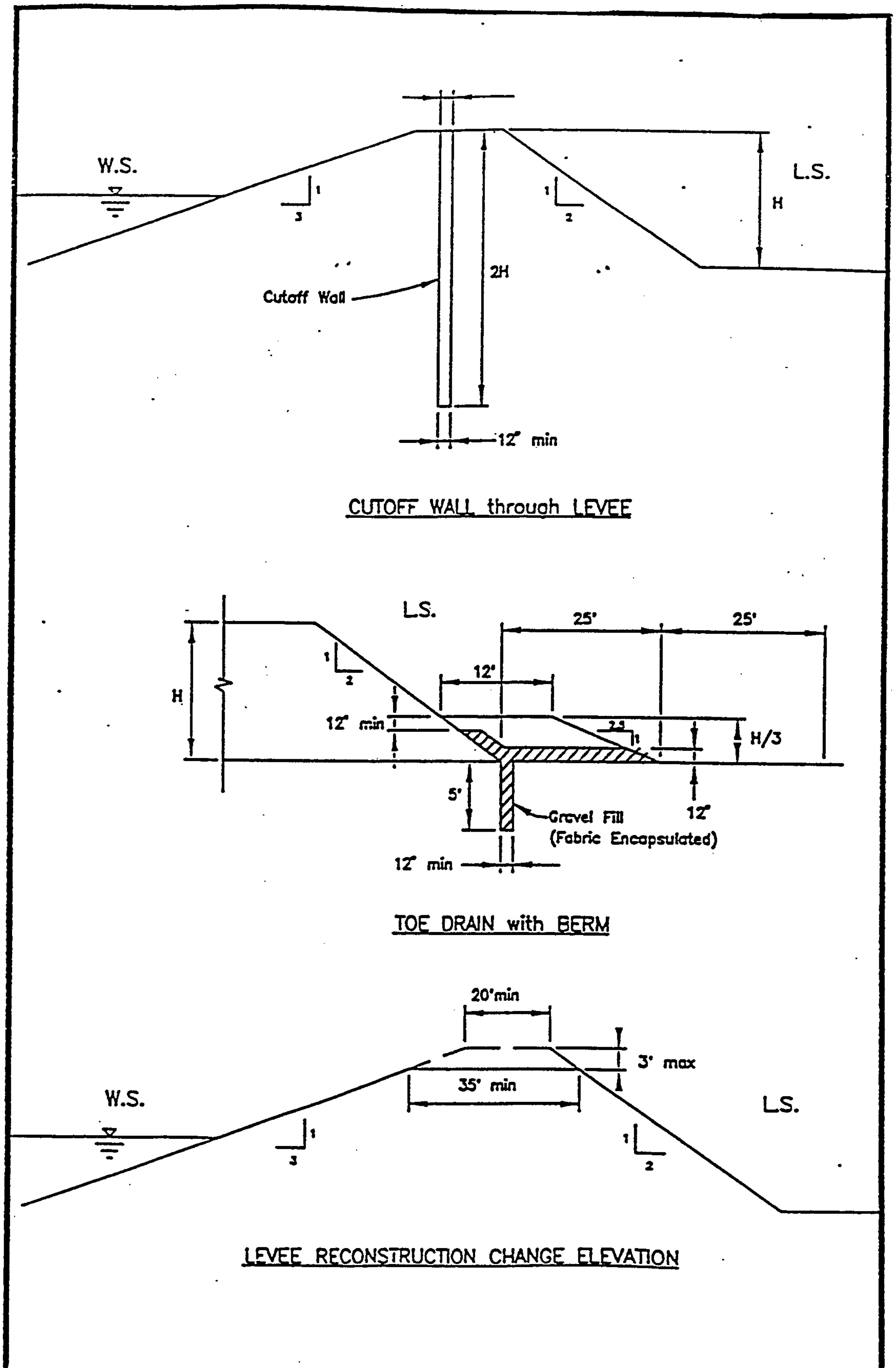


PLATE 6 Cross-section designs for the proposed remedial repairs for the Sacramento River Flood Control System Evaluation, Phase III project (Source: USACE 1991).

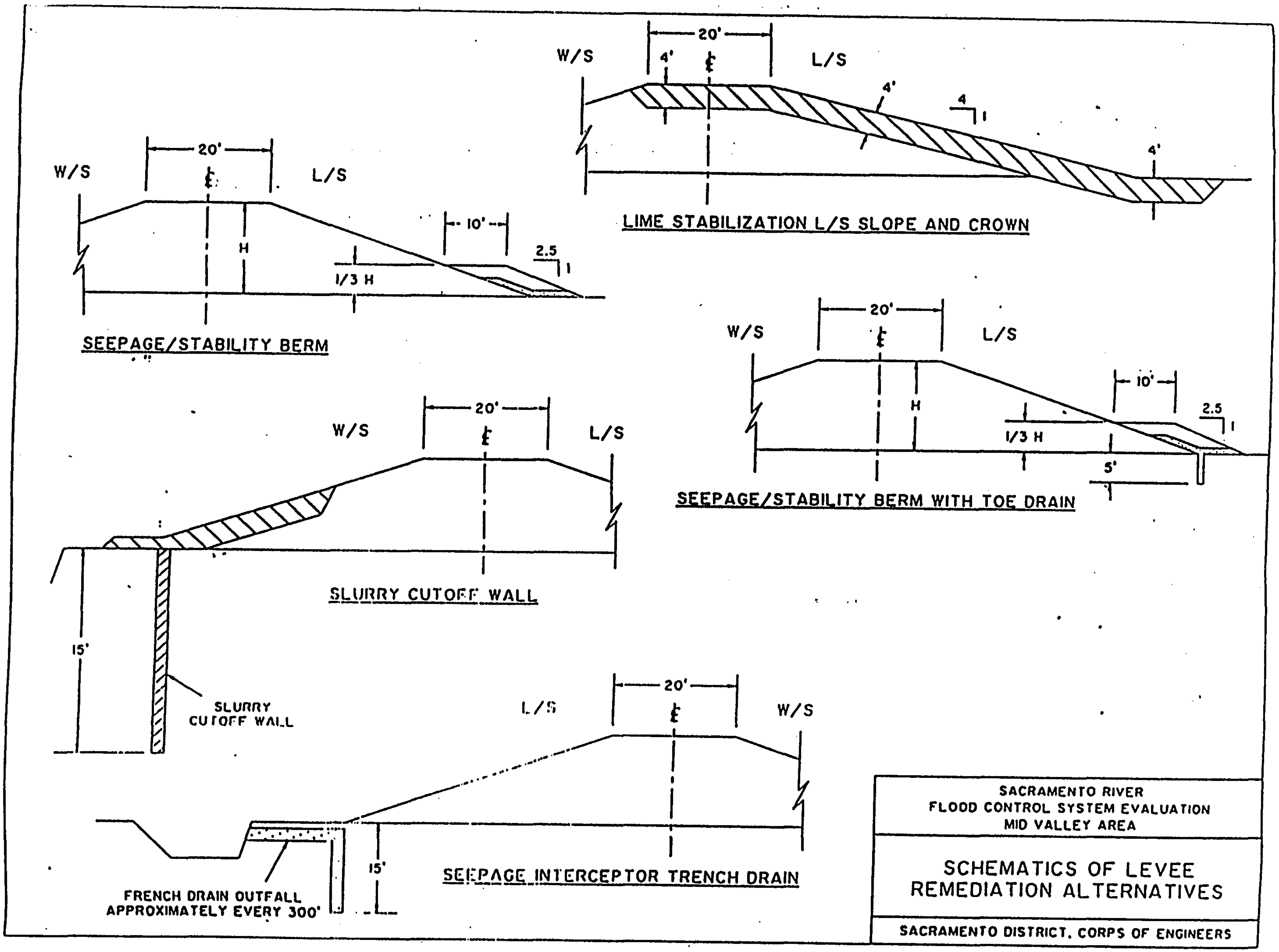


PLATE 7 Cross-section designs for the proposed remedial repairs for the Sacramento River Flood Control System Evaluation, Phase III project.

Appendix A

Detailed Report on Fish and Wildlife Resources/
Coordination Act Report

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

REVISED DRAFT

FISH AND WILDLIFE COORDINATION ACT REPORT

FOR THE

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION PHASE III

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS

SACRAMENTO, CALIFORNIA

FEBRUARY 1995

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Sacramento Field Office
2800 Cottage Way, Room E-1803
Sacramento, California 95825-1846

February 15, 1995

Mr. Walter Yep
Chief, Planning Division
Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814-2922

Subject: CE/SAC - Sacramento River Flood Control System Evaluation Project, Phase III (Mid-Valley Area)

Dear Mr. Yep:

Enclosed are three copies of the Fish and Wildlife Service's (Service) revised draft Fish and Wildlife Coordination Act Report (FWCA Report) for the Corps of Engineers' (Corps) Sacramento River Flood Control System Evaluation Project, Phase III (Mid-Valley Area). The Corps has added, deleted, and changed a number of sites for the project since we submitted our preliminary draft FWCA Report in August 1994, hence the need for a revised draft report.

The report describes the fish and wildlife resources of the project area, and the impacts the proposed project would have on those resources. We have also provided in this report a revised draft Habitat Evaluation Procedures (HEP) report (Appendix F), which quantifies impacts to fish and wildlife resources, and assesses potential mitigation measures to avoid or offset these impacts.

By copy of this letter, we are asking the Corps, California Department of Fish and Game, National Marine Fisheries Service, and Department of Water Resources, to provide their review comments, if any, by March 22, 1995. Any such comments will be given full consideration in the preparation of the Service's final report.

Thank you and your staff for the opportunity to provide our input to your planning process. Should you have any questions, please call Caroline Wilkinson of my staff at (916) 979-2107.

Sincerely,

Joel A Medlin

Joel A. Medlin
Field Supervisor

Enclosure

cc: FWS, ARD-ES, Portland, OR
CDFG, Region II, Rancho Cordova, CA (Attn: Dave Zezulak)
NMFS, Santa Rosa (Attn: James Bybee)
DWR, Sacramento (Attn: Wendy Halverson)

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

REVISED DRAFT

FISH AND WILDLIFE COORDINATION ACT REPORT

FOR THE

SACRAMENTO RIVER FLOOD CONTROL

SYSTEM EVALUATION

PHASE III

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS

SACRAMENTO, CALIFORNIA

PREPARED BY

CAROLINE W. WILKINSON

ECOLOGICAL SERVICES

SACRAMENTO, CALIFORNIA

FEBRUARY 1995

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

INTRODUCTION

This is our detailed Fish and Wildlife Coordination Act Report (FWCA Report) on the effects that the Army Corps of Engineers' (Corps) proposed Sacramento River Flood Control Systems Evaluation, Phase III would have on fish and wildlife resources. The proposed project involves levee repairs along about 18.27 miles of the Sacramento and Feather Rivers, as well as portions of Knights Landing Ridge Cut, Yolo Bypass, and Sutter Bypass. The report has been prepared under authority of, and in accordance with, the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401 as amended; U.S.C. *et seq.*). The report has been reviewed and concurred with by the California Department of Fish and Game (CDFG) in their appended letter of _______. The National Marine Fisheries Service (NMFS) has also reviewed the report and provided their input (see appended letter dated _______).

This report describes fish and wildlife resources found within the proposed project area and the impacts that proposed levee improvements, presently being investigated by the Corps, may have on these resources. This FWCA Report is based on engineering and other data provided by the Corps prior to January 20, 1995. Our appraisal of resources is based on a literature review; our own in-house expertise; personal communication with other recognized experts; aerial photographs; and field investigations conducted on April 1, 14, and 20, and May 19, 1994 for the preliminary draft, and December 15, 1994, January 12, and January 19, 1995 for the revised draft. Our analysis will not remain valid if the project, the resource base, or anticipated future conditions change significantly.

The purposes of this report are to: 1) evaluate the impacts of each alternative on fish and wildlife and their habitats; 2) identify and evaluate the least environmentally damaging alternative; and 3) recommend methods for avoiding, compensating losses of, and enhancing fish and wildlife resources.

We have applied the Service's Habitat Evaluation Procedures (HEP - Appendix F) to upland and wetland resources; we do not anticipate any significant aquatic resource impacts. The HEP provides a species-habitat approach to resource assessment and a means to calculate an index of habitat values using both quantitative and qualitative factors. The cover-types used by wildlife are appraised with respect to their value in providing the necessary habitat requirements for selected evaluation species. Habitat value is displayed as Habitat Units, the product of habitat quality (Habitat Suitability Index) and acres of available habitat. The objectives of these procedures are to define (in nonmonetary terms) impacts of the project, and to provide a basis for determining compensation and enhancement measures needed to maintain the integrity of the ecosystem. The HEP analysis, however, is not used to evaluate federally listed threatened and endangered species or candidate species. Listed species needs are separately considered, as provided for in the Endangered Species Act of 1973, as amended.

The project will adversely impact about 224.28 acres of terrestrial habitats including riparian forest, scrub-shrub, emergent marsh, permanent wetlands, and grasslands/agricultural lands (orchards). All acreage values were

determined from blueline aerial photographs provided by the Corps of Engineers (Corps). The riparian forest, scrub-shrub, emergent marsh, and permanent wetland habitats are of great importance to fish and wildlife because of the relatively high biodiversity, extensive linear distribution which provides corridors for wildlife, and abundant edge effects which enhance habitat values. A broad discussion of the historic losses of riparian habitat along the Sacramento River is found in the Service's FWCA Report for the Sacramento River Bank Protection Project, Contract 42A (USFWS 1993).

Our recommendations for mitigation are commensurate with the habitat values involved. Habitats range in value from those considered to be unique and irreplaceable to those believed to be relatively low in value to fish and wildlife. The riparian woodland, scrub-shrub, emergent marsh, and permanent wetland habitats are of high value to fish and wildlife and have become relatively scarce in the ecoregion, therefore, we are seeking mitigation that assures no loss of in-kind habitat value or acreage for each of these. The grassland/agricultural complex is more common in the ecoregion, and less valuable to wildlife, therefore, we are seeking to minimize loss of habitat value for this habitat.

PROJECT DESCRIPTION

The Sacramento River Flood Control Project, authorized by the Flood Control Act of 1960, consists of about 1,000 miles of levees plus overflow weirs, pumping plants and bypass channels that protect communities and agricultural lands in the Sacramento Valley and Sacramento-San Joaquin Delta (USFWS 1990). The present Corps of Engineers' study is being conducted to determine the long-term integrity of the flood control system for the Sacramento and Feather Rivers, and levees along the Yolo and Sutter Bypasses, and Knights Landing Ridge Cut. The study was initiated after the 1986 flood event which severely stressed the existing levee system in the study area, caused some levee failures, and hence, raised the question of levee reliability.

The Corps is currently undergoing a five-phase evaluation of the levee system for the Sacramento River Flood Control Project. The third phase, the subject of this report, concentrates on the Mid-Valley Area (Figure 1). Specifically, areas being considered for repair include levees along: the lower Feather River; left and right banks of the Sacramento River from Tisdale Bypass to just below the Fremont Weir; the right bank of the Sutter Bypass from Tisdale Bypass to the Fremont Weir; the left bank of the Yolo Bypass from the Sacramento Bypass to the Interstate 5 bridge which crosses over the Sacramento River; and the left bank of Knights Landing Ridge Cut (the "left" and "right" banks of the river refer to the orientation when facing downstream). Proposed borrow sites are located along the Tisdale Bypass, Fremont Weir, and near Cache Creek (in the Cache Creek Settling Basin).

The Sacramento District of the Corps and the Reclamation Board (Board) of the State of California are sponsors for the Mid-Valley Area Levee Reconstruction Project. In December 1991, an Initial Appraisal Report (IAR) was completed on the Sacramento River Flood Control System levees in the Mid-Valley Area. The IAR was conducted under authority of the Conference Report accompanying the Energy and Water Development Appropriations Act of 1987 (Public Law 99-591). The purpose of the study was: 1) to investigate the integrity of the existing project levees; 2) to evaluate the level of protection afforded by existing levees; 3) to determine whether or not the levees are functioning as designed; and 4) to determine if remedial actions are needed. Studies have shown that sections of the project levees are susceptible to seepage and stability problems, and do not provide the design levels of flood protection for a 50-year project life. Problems are occurring due to sandy soils and swelling clays/organic material found within the levee embankment and foundation.

The existing levee embankments were constructed based on: 1) a design discharge or channel capacity; 2) a design water surface profile; and 3) a minimum freeboard requirement above the design water surface profile (as authorized by the Flood Control Act of 1917). Therefore, the study objective was to develop reconstruction plans so that the project levees could safely pass the design flow, according to existing Corps criteria and guidance, at the design water surface (USACE 1991). About 18.27 miles of reconstruction work would be needed to meet project design requirements. Between 2,000 and 3,000 people live landward of the project levees; damageable property is estimated at $170 million (USACE 1991).

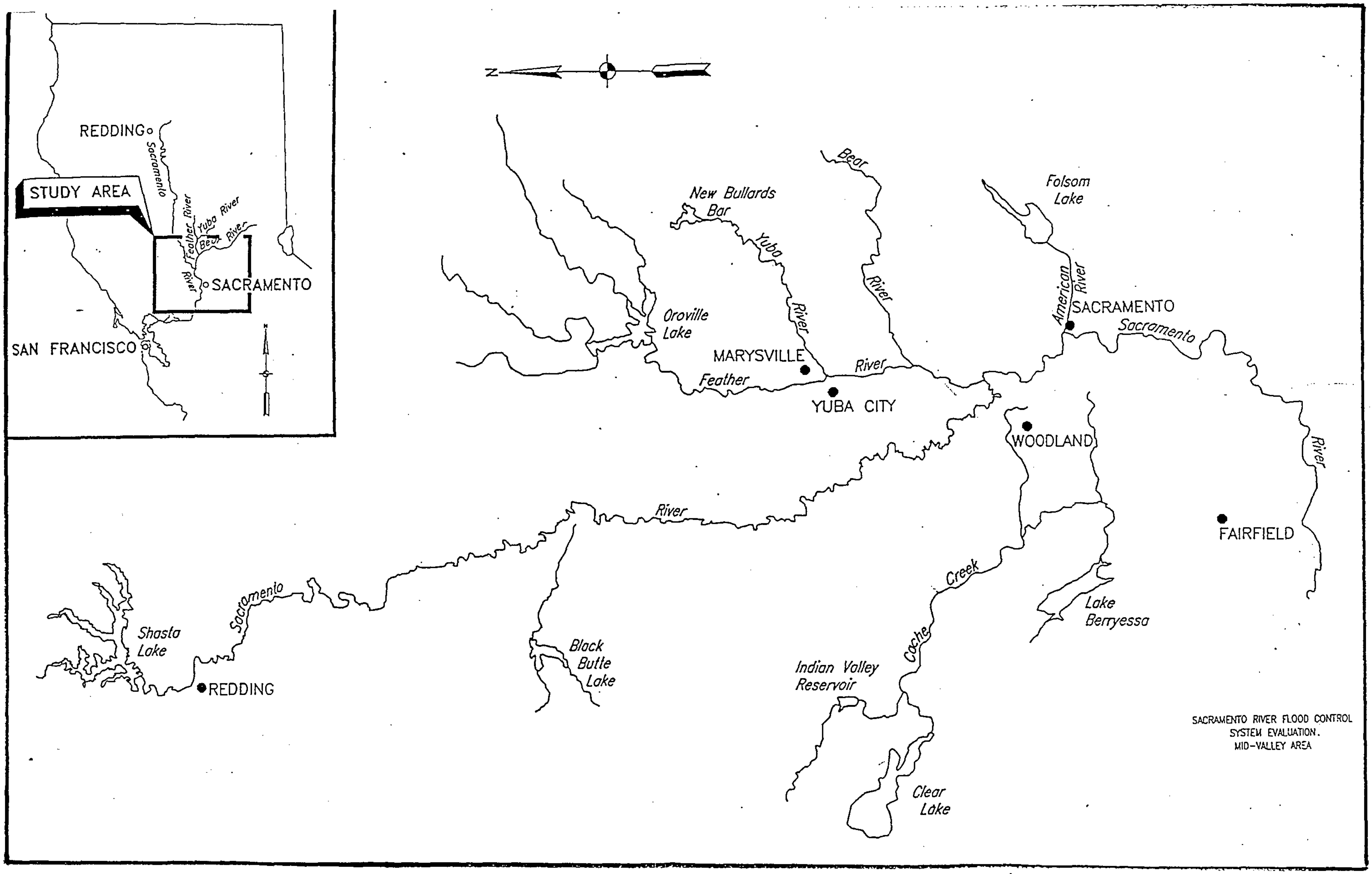


Figure 1. General map of the Sacramento River Flood Control System Evaluation, Phase III project area (Source: USACE 1991)

DESCRIPTION OF THE AREA

The Mid-Valley project area lies primarily to the north and west of the Sacramento Metropolitan area, encompassing portions of Sutter and Yolo Counties, and includes about 253 miles of the Sacramento River Flood Control Project levees along the Sacramento and Feather Rivers. The project area also includes portions of the Sutter and Yolo Bypasses and Knights Landing Ridge Cut (USACE 1991).

The Sacramento River system is the largest watershed in California, draining 26,300 square miles of the Central Valley, the Coast, Cascade and the Sierra Nevada mountain ranges. A system of levees bounds much of the Sacramento River downstream from the city of Chico to the Delta. Flows are regulated by major dams and reservoirs, such as Lake Shasta on the mainstem, and Whiskeytown, Oroville, New Bullards Bar, Folsom, Black Butte, and Berryessa on the tributaries. In addition, water is transferred from the Trinity River to the Sacramento River via Whiskeytown and Keswick Reservoirs. Since the construction of these storage facilities, the river has been used to transport water to the Sacramento-San Joaquin Delta and the state and federal export pump facilities of the State Water Project and Central Velley Project. The sustained high-water level during the summer months, although controlled by upstream developments, contributes to some streambank erosion. The major factor contributing to the erosion of riverbanks, however, is winter flood flows. This has been attenuated due to decreasing annual precipitation and subsequent low flows for the past several years. Two-thousand square miles of fertile agricultural land and about fifty communities are located in the Sacramento River floodplain (USFWS 1990).

DESCRIPTION OF ALTERNATIVES

Th· ·urposes of the Sacramento River Flood Control System Evaluation are to e: ..ne the existing flood control system as designed, and to develop remedial re. air plans to restore the design level of protection. Technical studies determined that the problems experienced are primarily the result of geotechnical inadequacies, and would not increase the design level of protection (USACE 1991). The general locations of the proposed remedial repairs and borrow sites are shown in Figure 2.

The alternatives being considered for remedial repair would generally entail working on the landside levee slope and the landside levee toe. This would minimize impacts to waterside riparian habitats. Construction alternatives being considered would include work in existing permanent easements, new permanent easements, and temporary easements.

About 18.27 levee miles require repairs. The construction alternatives would consist of: 1) toe drain and berm construction; 2) levee crown restoration; 3) slurry trench cut-off wall construction; 4) lime treatment of levee material; 5) filling and/or relocating existing drainage ditches; 6) seepage interceptor trench drains; and 7) seepage stability berms (Figures 3 and 4). The alternatives are discussed in detail as follows:

No Action Alternative

No action. This alternative would consist of maintaining the project levees in their current condition. This alternative would likely result in levee failure for flood events of lesser magnitude than specified for design conditions, economic damages, and possible loss of life. The overall extent of damages would depend upon several factors, including magnitude and duration of flooding, and the success of emergency flood fighting efforts. Significant costs could be incurred for reconstruction of structures damaged by floods.

Construction Alternatives

1) **Toe drain and berm construction improvements.** This alternative would consist of constructing drainage improvements at the landward toe of the existing levee embankment. The drainage improvements are primarily toe drains that would be constructed about 2-feet-wide and 5-feet-deep (Figure 3). A pipe would be placed at the bottom of the toe drain, and the excavated area filled with imported coarse material. The toe drains would intercept and convey seepage waters away from the toe of the levee. Site impacts would consist of removing vegetation (clearing and grubbing) on the landside slope of the easement areas. Work would typically be done along the landside toe, and the landside levee slopes would be regraded to a specified slope. Generally there would be no berms or drains at ramps and raised areas where existing residences are located (C. Gaines, pers. comm.).

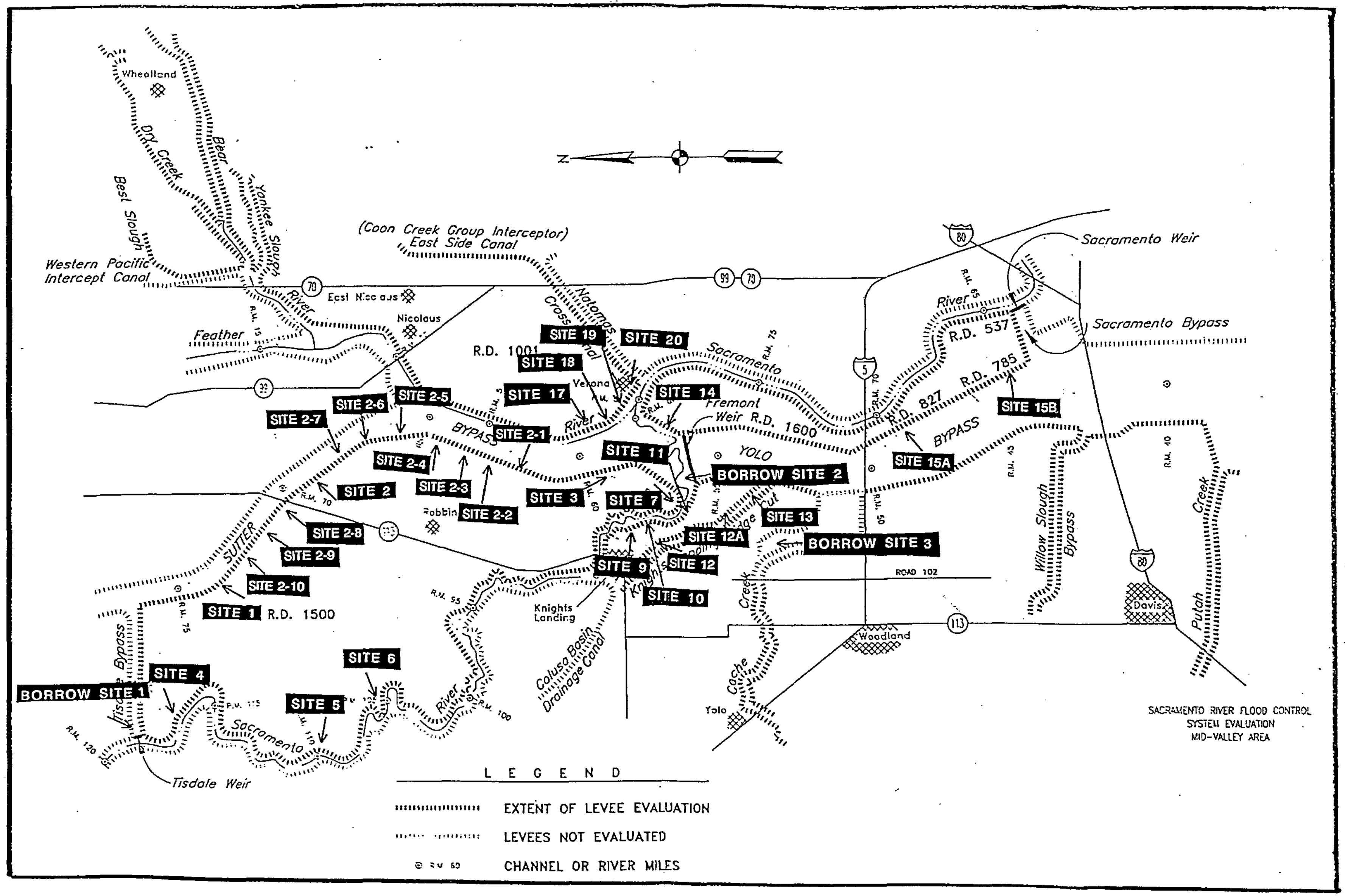


Figure 2. General site locations of the proposed remedial repairs and borrow sites for the Sacramento River Flood Control System Evaluation, Phase III project (USACE 1991).

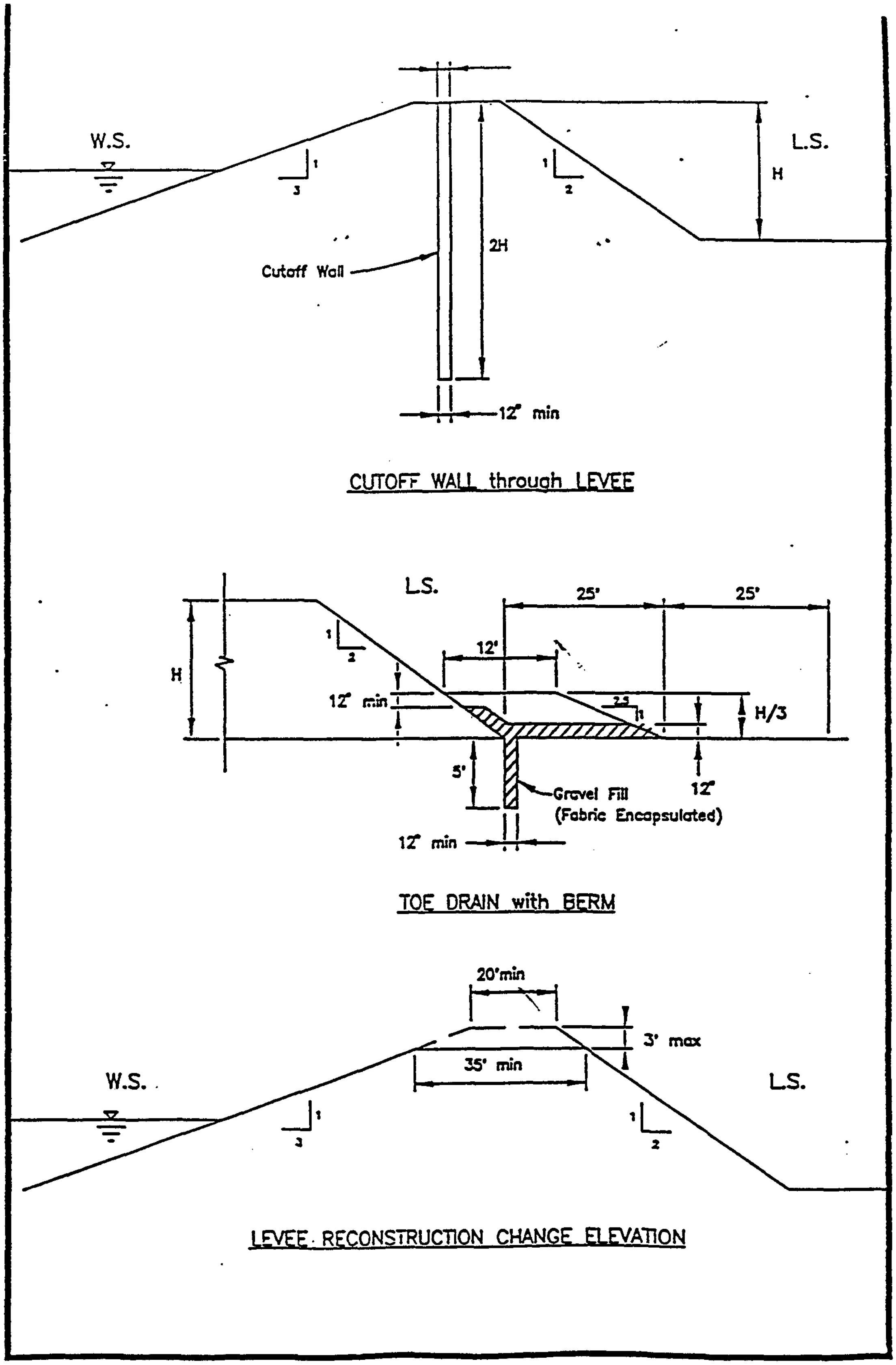


Figure 3. Cross-section designs for the proposed remedial repairs for the Sacramento River Flood Control System Evaluation, Phase III project (Source: USACE 1991).

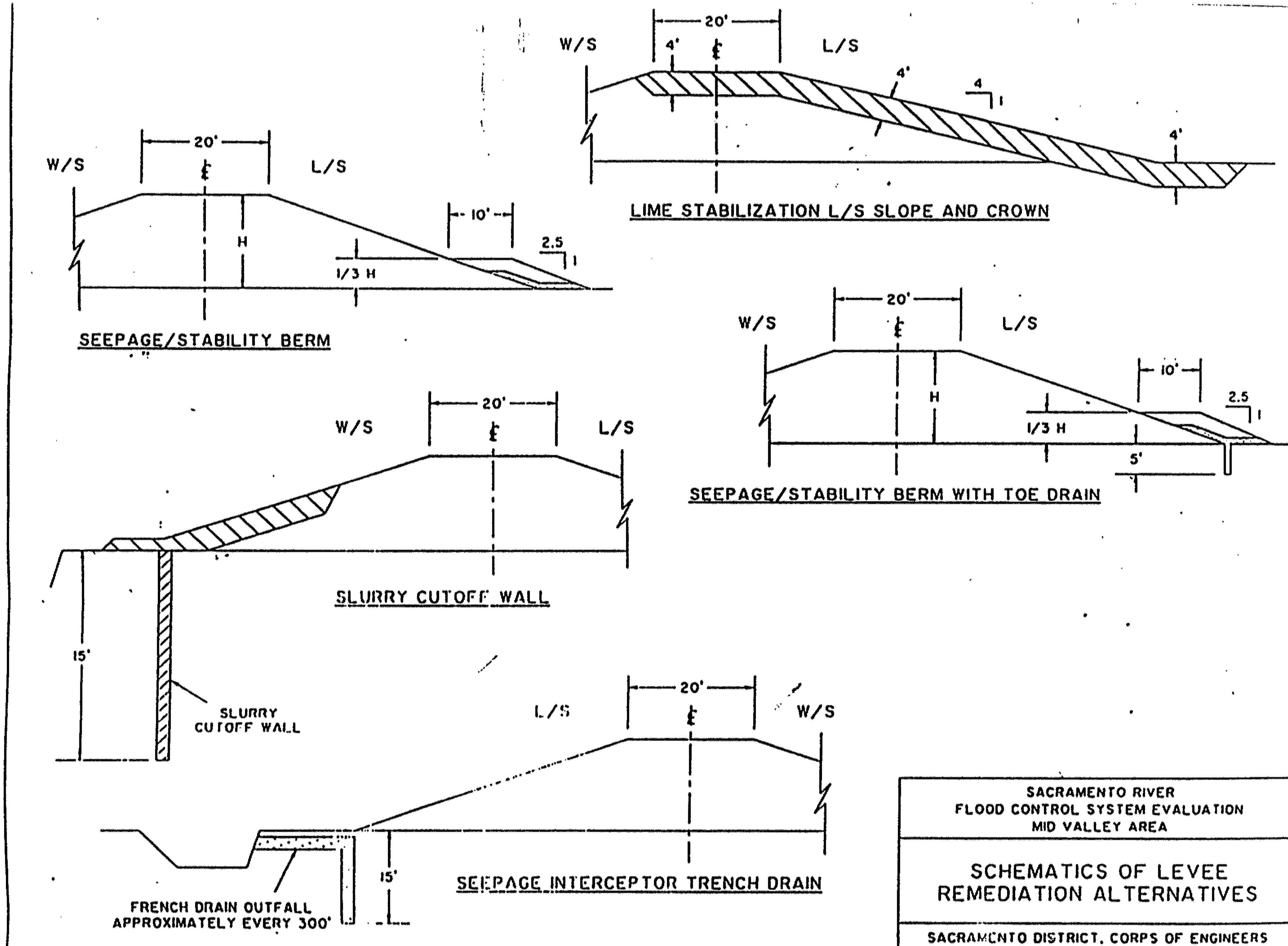


Figure 4. Cross-section designs for the proposed remedial repairs for the Sacramento River Flood Control System Evaluation, Phase III project.

2) **Levee crown restoration.** This alternative would consist of raising the existing levee crown elevation in reaches which do not have the minimum required design freeboard above the design water surface (Figure 3). Site impacts would consist of removing vegetation (clearing and grubbing) on the top of the levee crown, and possibly 1-2 feet on the waterside and landside slopes where dirt may fall from the grading. A 20-foot-wide temporary easement would be acquired for truck and equipment traffic, if necessary, to construct at Sites 15A and 15B (C. Gaines, pers. comm.).

3) **Constructing slurry trench cut-off walls.** This alternative would consist of digging a trench down the middle of the levee and filling it with an impervious material, thus improving structural stability. A 3-foot-wide trench would be dug in the center of the levee crown which would extend into the levee foundation. This trench would then be filled with the appropriate material to minimize seepage through the levee. Site impacts would consist of removing vegetation (clearing and grubbing) just on the levee crown and using a trenching machine, backhoe, and other equipment on the top of the levee. A staging area would be used to mix the cement, bentonite, and other material which would be pumped into the cutoff wall (C. Gaines, pers. comm.)

4) **Lime treatment.** This alternative would consist of removing a 4-foot depth of levee material from the crown and landside slope to about 10 feet beyond the levee toe, mixing the material with lime, and recompacting it to an established landside slope. The levee slopes and crown would be reconstructed during the process. Site impacts would consist of removing vegetation (clearing and grubbing) on the crown and landside slope to about 10 feet beyond the toe, and about the top 5 feet of the waterside slope.

5) **Filling and/or relocating existing drainage ditches.** Site impacts would consist of digging a new ditch, and filling in and recompacting the old ditch with materials dug from the new ditch. No work would be done on the existing levee slope, except possibly construction of an access ramp if needed. A staging area of about 1 acre would be located in nearby agricultural lands. No clearing or grubbing would occur at the new ditch site. Impacts would also occur from trucked and wheeled machinery to move the dirt (C. Gaines, pers. comm.).

6) **Seepage interceptor trench drain.** This alternative would consist of cutting a 15-foot-deep trench, about 2 feet wide, and filling it with sand. Every 300 feet or so, a perpendicular French drain or piping would empty into the adjacent irrigation canal. Site impacts would consist of removing vegetation (clearing and grubbing) along the landside toe to about 10 feet beyond the toe, and clearing and grubbing a perpendicular area to the toe about 10 feet wide every 300 feet.

7) **Seepage stability berm.** This alternative would consist of constructing drainage improvements at the landside toe of the existing levee embankment. A drainage blanket would be placed along the lower landside

slope and about 10 feet landward of the landside toe with a stability earth berm constructed over the drainage blanket. Site impacts would consist of removing vegetation (clearing and grubbing) along the landside toe to about 10 feet beyond the toe as well as about 10 feet up the lower landside levee slope. Generally, there would be no berms constructed where ramps or raised areas around exsiting structures are located.

The proposed repair work would consist of a combination of the above alternatives at the 30 work sites. Table 1 presents the repair alternatives which are proposed for each site, and levee miles and acres that would be impacted. Three borrow sites would also be used; their location and impact acreages are presented in Table 1. Acreage for borrow sites was determined by planimetering the sites outlined by the Corps on aerial photographs.

Table 1. Site locations, proposed remedial repair work alternatives, miles impacted, and acres impacted for the Sacramento River Flood Control System Evaluation, Phase III project.

SITE #, LOCATION, AND RIVER MILE	PROPOSED REMEDIAL REPAIR WORK	MILES IMPACTED	ACRES IMPACTED
1-Sutter Bypass 17.9-18.6R	Seepage interceptor trench drain	0.70	0.09
2-Sutter Bypass 13.75-14.75R	Seepage interceptor trench drain	1.00	0.12
2-1 Sutter Bypass 4.22R	Seepage interceptor trench drain	0.05	0.01
2-2 Sutter Bypass 4.89R	Seepage interceptor trench drain	0.05	0.01
2-3 Sutter Bypass 7.67R	Seepage interceptor trench drain	0.05	0.01
2-4 Sutter Bypass 9.13R	Seepage interceptor trench drain	0.03	0.01
2-5 Sutter Bypass 9.53-9.60R	Seepage interceptor trench drain	0.06	0.01
2-6 Sutter Bypass 10.32-10.38R	Seepage interceptor trench drain	0.06	0.01
2-7 Sutter Bypass 12.09R	Seepage interceptor trench drain	0.03	0.01
2-8 Sutter Bypass 15.45R	Seepage interceptor trench drain	0.02	0.01
2-9 Sutter Bypass 16.12R	Seepage interceptor trench drain	0.03	0.01
2-10 Sutter Bypass 17.14R	Seepage interceptor trench drain	0.03	0.01
3-Sutter Bypass 2.0-3.0R	Lime treatment, ditch relocation	1.00	14.65
4-Sacramento River 116.2-117.2L	Berm/toe drain.	1.00	14.60
5-Sacramento River 109.9-110.5L	Fill seasonal ditch, restore landside toe	0.60	5.14
6-Sacramento River 104.8-105.7L	Berm/toe drain.	0.87	12.67
7-Sacramento River 85.2-85.9L	Berm/toe drain.	0.70	10.19
9-Sacramento River 87.1-87.3R	Berm/toe drain.	0.20	1.93
10-Sacramento River 86.8-86.9R	Berm/toe drain.	0.10	1.38
11-Sacramento River 85.2-85.6R	Berm/toe drain.	0.40	5.51
12-Knights Landing Ridge Cut	Lime treatment, ditch relocation, reshape levee.	2.17	43.82
12A-Knights Landing Ridge Cut	Lime treatment	0.85	10.33
13-Knights Landing Ridge Cut	Lime treatment, ditch relocation	0.38	6.47
14-Sacramento River 80.8-81.5R	Berm/toe drain	0.70	10.19
15A-Yolo Bypass	Restore levee crown, lime treatment, ditch relocation.	1.32	20.25
15B-Yolo Bypass	Restore levee crown, lime treatment	4.82	51.24
17-Feather River 2.2-2.4L	Berm/toe drain and cutoff wall or stabilize berm	0.20	2.57
18-Feather River 0.78-0.93L	Cutoff wall or stabilize berm	0.15	2.57
19-Feather River 0.35-0.55L	Berm/toe drain and fill in ditch.	0.20	2.75
20-Sacramento River 79.0-79.5L	Berm/toe drain or stabilize berm.	0.50 TOT. 18.27	7.71 TOT. 224.28
Borrow Site 1, near Tisdale Weir Borrow Site 2, near Fremont Weir Borrow Site 3, near Cache Creek Settling Basin			20.00 48.00 40.00 TOT. 108.00

EXISTING BIOLOGICAL RESOURCES

Vegetation

Many significant and diverse cover-types are found within the general Mid-Valley project area, which are critical to fish and wildlife populations. The following discussion pertains to cover-types within the specific project area.

Sacramento and Feather Rivers. Within the project area, vegetation along the Sacramento and Feather Rivers varies in density, width, and species composition, depending on numerous physical parameters such as hydrology, elevation, land use, placement of riprap, location of levees, and levee maintenance practices (USFWS 1990). Cover-types found include riparian woodland, riparian scrub-shrub, permanent freshwater marsh, seasonal marsh, and annual grassland.

Riparian vegetation along the banks of the Sacramento River occurs in varying conditions within the project area. Where vegetation is present, it usually occurs in narrow but dense bands along the banks. Setback levees in some areas allow larger parcels of dense, high value riparian habitat to occur adjacent to the river. Much of the Sacramento River between Verona and the Tisdale Weir has undergone extensive bank protection work and levee maintenance. These practices have permanently eliminated or degraded much of the riparian vegetation in these areas, resulting in little, if any, habitat value for fish and wildlife species. Along the Feather River from its confluence with the Sacramento River to Highway 99, riparian forest habitat consists primarily of a dense, relatively wide band of vegetation on the west bank of the river. Vegetation on the east bank is relatively narrow and sparse (USFWS 1990) due to the proximity of the levees and Garden Highway to the river.

Within the riparian corridor, tree canopy consists primarily of valley oak (*Quercus lobata*), sycamore (*Platanus racemosa*), cottonwood (*Populus fremontii*), and willow (*Salix* spp.). California grape (*Vitus californica*) and mistletoe (*Phoradendron californicum*) are sometimes present. A well-defined woody understory typically consisting of box elder (*Acer negundo*), black walnut (*Juglans hindsii*), white alder (*Alnus rhombifolia*), Oregon ash (*Fraxinus latifolia*), blue elderberry (*Sambucus cerulea*), and smaller cottonwood occurs in most undisturbed areas. California grape, blackberry (*Rubus vitifolius*), mugwort (*Artemesia douglasiana*), western ragweed (*Ambrosia psilostachya*), pigweed (*Chenopodium* spp.), clover (*Melilotus* spp. and *Trifolium* spp.), cocklebur (*Xanthium strumarium*), several thistles (*Cirsium* sp.), grasses, and forbs form an often dense ground cover. Non-native woody species which may be commonly found include *Eucalyptus*, giant reed (*Arundo donax*) and honey locust (*Robinia pseudo-acacia*) (USFWS 1990). Generally, on the waterside of the levees, riparian vegetation occurs up to the levee toe.

Riparian scrub-shrub cover-type is also found in the study area. It is defined as habitat dominated by woody vegetation less than 20 feet tall. Species include shrubs, young trees, and trees and shrubs that are small or stunted because of environmental conditions. Specific species found in the study area include raspberry (*Rubus idaeus*), wild rose (*Rosa californica*), blue elderberry, box elder, valley oak, and black walnut. Mixed scrub-shrub areas typically consist of a dense thicket of three or more shrub and/or young tree species. Typical species are similar to the shrub and young tree understory species described for the dense, mature riparian forest habitat type.

Permanent freshwater marshes may be found in several reaches of the Sacramento and Feather Rivers and associated sloughs. They are characterized by persistent, dense stands of non-woody emergent vegetation. Common species include cattails (*Typha latifolia*), bulrush (*Scirpus* spp.), umbrella sedge

(*Cyperus* spp.), smartweed (*Polygonum punctatum*), iceplant (*Mesembranthemum edule*), California hibiscus (*Hibiscus californicus*) and marsh pennywort (*Hydrocotyle ranunculoides*). Marshes provide critical feeding habitat and cover for certain waterfowl, such as surface-feeding and diving ducks, and for wading birds, such as egrets and herons (USFWS 1990). Seasonal marshes, such as those found in drainage ditches, may provide food, cover, and water for species such as the great egret. Riparian and emergent marsh vegetation occur along a number of seasonal irrigation delivery ditches found in the project area.

On the landward side, grassland and agricultural lands are most abundant. Levee slopes and berms may contain several varieties of grasses, forbs, and weeds. Some worksite grasslands also support some woody tree species, such as cottonwood or willow. The lack of much woody vegetation is due mainly to levee maintenance activities, including burning, discing, spraying, and mowing. However, these areas provide valuable habitat for small mammals, such as rabbits and mice, which in turn provide a food base for larger animals, such as coyotes and raptors (USFWS 1990).

Sutter Bypass. Narrow strips of riparian forest habitat line both banks of the river within the existing levees. The levee slopes and outside toe of the levee are covered by herbaceous vegetation, and essentially are void of any trees or shrubs (USFWS 1990).

Yolo Bypass. In the project area, vegetation waterward of the levee consists primarily of very narrow strips of riparian habitat dominated by willows, alders, and oaks. A dense stand of trees occurs on the west bank while the east bank, having undergone substantial revetment work, supports only a very sparse scattering of trees (USFWS 1990).

Knights Landing Ridge Cut. Riparian forest and freshwater marsh comprise the cover-types found here. Dominant species found in the riparian forest include Fremont cottonwood, willows, California grape, and poison oak (*Toxicodendron diversilobum*). Freshwater marshes in this area are permanently flooded by fresh water, lack a water current, and accumulate deep, peaty soils. Dominant species include cattails and bulrushes (USACE 1992). Plant species found along the east side of Knights Landing Ridge Cut are listed in Appendix A. Many of these species may be found throughout the project area.

Annual grasslands are found at all project sites, primarily on the levee slopes. In many areas, grassland vegetation occurring on levee crowns is removed by burning or discing, or is prevented from establishing due to regular vehicle use. Most of the grassland habitat along the channel reaches is moderately to highly disturbed; characteristic plant species include star thistle (*Cirsium* sp.), foxtail brome (*Bromus* spp.), wild mustard (*Brassica campestris*), and other annual grasses.

Wildlife

The composition, abundance, and distribution of wildlife resources in the project area is directly related to available habitat. Overall, wildlife found in the project area is diminished from the period before agricultural development permanently removed much of the natural habitat. Many wildlife species are unable to adapt to other habitat types or altered habitat conditions. These specialists are therefore most susceptible to habitat loss and degradation. Species which were dependent on riparian woodland, oak woodland, marsh, and grassland habitats have declined accordingly (USFWS 1990).

Riparian forest, with its multi-strata structure, dense cover, and high plant species diversity, is especially productive, supporting the highest numbers and diversity of wildlife species. Existing information indicates that, in

California, about 25 percent of native land mammal species, 50 percent of reptile species, and 75 percent of amphibian species are dependant on riparian habitats (USFWS 1990). Invertebrates, both terrestrial and aquatic forms, are also supported in high numbers by riparian habitats. Invertebrates provide essential food sources for birds and other vertebrates. They regulate vegetative growth and pollinate most flowering plants, thus insuring their reproduction. Restrictions in geographic movement make invertebrates especially vulnerable to habitat alteration (USFWS 1990).

The existing native habitat, especially the riparian corridors occurring along the waterways, provides habitat for many native mammal species. Blacktail jackrabbit (*Lepus californicus*), western gray squirrel (*Sciurus griseus*), red fox (*Vulpes fulva*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), raccoon (*Procyon lotor*), opossum (*Didelphis marsupialis*), mink (*Mustela vison*), longtail weasel (*Mustela frenata*), striped skunk (*Mephitis mephitis*), spotted skunk (*Spilogale putorius*), badger (*Taxidea taxus*), muskrat (*Ondatra zibethica*), river otter (*Lutra canadensis*) and beaver (*Castor canadensis*) are all found in the project area (USFWS 1990).

Native habitat also provides nesting and feeding habitat for resident birds. The Sacramento River system is part of the Pacific Flyway and provides important resting and feeding areas for migratory waterfowl, shorebirds, and other water-associated birds. Common bird species found in the project area include California quail (*Callipepla californica*), ring-necked pheasant (*Phasianus colchicus*), mourning dove (*Zenaida macroura*), band-tailed pigeon (*Columba fasciata*), common merganser (*Mergus merganser*), mallard (*Anas platyrhynchos*), great blue heron (*Ardea herodias*), great egret (*Casmerodius albus*), belted kingfisher (*Ceryle alcyon*), marsh wren (*Cistothorus palustris*), song sparrow (*Melospiza melodia*), various owls (Strigidae family), various woodpeckers (Picudae family), red-tailed hawk (*Buteo jamaicensis*), and Swainson's hawk (*Buteo swainsoni*) (USFWS 1990). A complete list of bird species found along the Sacramento River is included Appendix B.

Amphibians and reptiles found in the project area include the gopher snake (*Pituophis melanoleucus*), western fence lizard (*Sceloporus occidentalis*), common garter snake (*Thamnophis sirtalis*), and Pacific tree frog (*Hyla regilla*) (USFWS 1990).

Fish

Sacramento River. The Sacramento River supports an array of anadromous and resident fish species. Anadromous fishes of the Sacramento River system in the project area include winter-run chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Oncorhynchus mykiss*), striped bass (*Morone saxatilis*), American shad (*Alosa sapidissima*), white sturgeon (*Acipenser transmontanus*), and green sturgeon (*Acipenser medirostris*). Resident warmwater fish include largemouth bass (*Micropterus salmoides*), catfish (Ictaluridae family), bluegill (*Lepomis macrochirus*), tule perch (*Hysterocarpus traski*), and sunfish (Centrarchidae family) (USFWS 1990).

Of greatest importance to California fisheries is the chinook salmon. The Sacramento River supports the largest chinook salmon population in the state. About 90 percent of the Central Valley salmon population spawns in this system (USFWS 1990). Four genetically distinct species of chinooks presently use the river: fall-, late fall-, winter- and spring-run. Fall-run salmon are most abundant, comprising about 80 percent of the four runs (USFWS 1990). Hallock (1987) states: "*Total numbers of salmon that spawn in the Upper Sacramento River system have declined more than 75 percent since the 1950's. Fall-run salmon, which make up more than 90 percent of the total, appear to be stabilized at a low level of 200,000 fish; 85 percent spawn naturally and 15 percent are spawned artificially at hatcheries. However, on streams where there are hatcheries, populations are increasing, which is masking the true*

picture, i.e., the natural spawning populations are declining in the Upper Sacramento River system." Winter-run salmon have experienced the most precipitous decline and were listed as endangered species in 1994 by NMFS. Counts of winter-run salmon passing the Red Bluff Diversion Dam from 1967 ranged from a high of 117,080 in 1969 to a low of 400 adults in 1989 (USFWS 1990). Documentation of the fall-run chinook salmon decline is extensive, indicating the 1985 population count is about 17 percent of the spawning population in the 1950's (USFWS 1990). Between the four races of salmon and steelhead trout, some life stages of salmonids may be found in the Sacramento River system at any given time of year (USFWS 1990).

Adult steelhead trout use the lower and middle Sacramento River as a migration corridor into the upper Sacramento River system during the fall and winter. Spawning occurs in most tributaries with year-round flows from December through April. Juveniles migrate downstream primarily in the spring after 2 or more years of rearing in upstream areas. The current steelhead population is estimated at less than half their numbers from the 1950's (USFWS 1990).

Most of California's shad and striped bass spawn in the Sacramento River system. The American shad population has flourished in recent years, and is estimated to be several million (USFWS 1990). Striped bass populations, however, are experiencing a decline. In the 1960's, the striped bass population for the Sacramento River was estimated to be 3.0 to 4.5 million; in the 1970's, the population declined to 1.7 million. In 1977, the population was between 0.8 to 1.2 million (USFWS 1990). It continues to steadily decline (USFWS 1990).

White sturgeon populations are also considered unstable. Although population estimates have increased substantially since the 1970's, extreme fluctuation in numbers of fish is of concern. It is estimated that about 130,000 fish now reside in the Sacramento River (USFWS 1990). Other fish species, including largemouth bass, crappie, bluegill and sunfish, can be found in the study area. These species use river backwater areas where current velocities are slower and more conducive to requirements of the fish (USFWS 1990).

Most species may be found along vegetated shorelines of the river and associated sloughs where valuable cover is provided by overhanging and/or partially submerged shrubs or trees (referred to as Shaded Riverine Aquatic (SRA) Cover). SRA Cover is found along rivers and streams, where overhanging vegetation and/or submerged woody debris exists (USFWS 1992), usually along natural banks which are not riprapped or maintained by local flood control districts. This provides cooler shaded environment for a portion of the day to fish and other aquatic organisms (USFWS 1990) by either reducing water temperatures (especially important in smaller rivers) or reducing sunlight radiation heating on aquatic organisms. Cover of this type may also be provided by uneven bank edges or crevices within the bank. Higher insect populations associated with riparian vegetation are important food sources for many fish, including salmonid species. Also, leaf litter and submerged vegetation provide a detritus base for aquatic insects and microorganisms. The productive interaction of terrestrial and aquatic environments consequently provides a valuable cover type for fish (USFWS 1990).

Species such as the Sacramento squawfish (*Ptychocheilus grandis*), hardhead (*Mylopharodon conocephalus*), and Sacramento sucker (*Catostomus occidentalis*) are most abundant in the larger tributaries between the 300- to 2,000-foot elevation. They prefer large, deep, well-shaded, sand- or rock-bottomed pools. Fish habitat is substantially enhanced by the diversity offered by this land-water interface and adjacent berms (USFWS 1990). Appendix C lists the fishes of the entire Sacramento River system.

Feather River. Fish resources of the Feather River include anadromous species such as chinook salmon, steelhead trout, American shad, striped bass, green

and white sturgeon, and Pacific lamprey (*Lampetra tridentata*). The number of adult chinook salmon returning to spawn on the Feather River averages nearly 51,000, 15 percent of which return to the Feather River Hatchery at Oroville. About 20,000 steelhead trout use the Feather River for spawning and rearing. Spawning by both species takes place above Marysville (USFWS 1990).

The Feather River supports one of the only two known established populations of northern spotted bass (*Micropterus punctulatus*) in California. The other population resides in the Consumnes River. Spotted bass is an introduced species, brought to California from Ohio in 1933 (USFWS 1990).

Yolo Bypass. The same anadromous fish species identified in the Sacramento River system are also occasionally present in several of the borrow ditches within the Yolo Bypass, such as the Tule Canal and Knights Landing Ridge Cut. Some of the borrow ditches adjacent to the levees support a significant warmwater fishery consisting of largemouth bass, crappie, catfish and bluegill. Several nongame fish such as carp (*Cyprinus carpio*), suckers, several minnow species (Cyprinidae family), and mosquitofish (*Gambusia affinis*) are also present. SRA Cover is scarce in these areas, and occurs when an occasional shrub or tree is present (USFWS 1990).

Most of the species found in the Sacramento River system may enter the Yolo Bypass during high flow events. There is little information available on fish population levels, habitat conditions, and sportfishing effort and success in the Yolo Bypass, borrow ditches, and canals within the Yolo Bypass (USFWS 1990).

Sutter Bypass. As with the Yolo Bypass, fish species composition in the Sutter Bypass would be expected to be similar to those found in the Sacramento River. Fish surveys were conducted in the Sutter Bypass by Jones and Stokes Associates in May 1993. Species found included chinook salmon, Sacramento squawfish, Sacramento splittail (*Pogonichthys macrolepidotus*), hitch (*Lavinia exilicauda*), fathead minnow (*Pimephales promelas*), carp, red shiner (*Notropis lutrensis*), golden shiner (*Notemigonus crysoleucas*), Sacramento sucker, mosquito fish, inland silverside (*Menidia audens*), threadfin shad (*Dorosoma petenense*), channel catfish (*Ictalurus punctatus*), logperch (*Percina macrolepida*), redear sunfish (*Lepomis microlophus*), bluegill, white crappie (*Pomoxis annualris*), large-mouth bass, and goldfish (*Carassius auratus*).

Knights Landing Ridge Cut. Many of the same species found in the Sacramento River would be expected to occur in the Ridge Cut. Specific species information is unavailable at this time.

Endangered Species

The following discussion of federally-listed threatened and endangered species should be regarded as preliminary information, which we are providing only to assist the Corps in preparation of a Biological Assessment, should one be deemed necessary. Appendix D provides a list of the species (dated April 12, 1994) and a summary of a Federal agency's responsibilities under Section 7(a) and (c) of the Endangered Species Act (Act) of 1973, as amended.

We recommend that the Corps review its requirements, published in 50 CFR 402, for compliance with the Act. The Service has consultation responsibility for most of the federally-listed species that may be affected by the project, and this office should be contacted regarding further consultation requirements. However, the NMFS has responsibility for most marine fish and wildlife, such as winter-run chinook salmon, and should be consulted on activities which may affect any such listed or proposed species in the project area.

The Corps should request in writing from the Service a list of threatened and endangered species that may occur in the project area, or an updated list if

an earlier list is more than 90 day old at the time preparation of any Biological Assessment for this project is undertaken.

The CDFG was contacted regarding state-listed threatened and endangered species in the project area (Appendix E). They should be contacted if any state-listed species may be affected by the proposed project.

There are 16 threatened and endangered species, and proposed threatened and endangered species, that may occur in the project area. Endangered species are the palmate-bracted bird's-beak (*Cordylanthus palmatus*), Solano grass (*Tuctoria mucronata*), American peregrine falcon (*Falco peregrinus anatum,*), winter-run chinook salmon, and vernal pool tadpole shrimp (*Lepidurus packardi*). Threatened species are the bald eagle (*Haliaeetus leucocephalus*), Aleutian Canada goose (*Branta canadensis leucopareia*), giant garter snake (*Thamnophis gigas*), delta smelt (*Hypomesus transpacificus*), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), and vernal pool fairy shrimp (*Branchinecta lynchi*). One proposed endangered species is the Hartweg's golden sunburst (*Pseudobahia bahiifolia*). Proposed threatened species are Colusa grass (*Neostapfia colusana*), slender Orcutt grass (*Orcuttia tenuis*), and Sacramento splittail (*Pogonichthys macrolepidotus*).

Following are the 25 candidate species which may be found in the project area:

suisun aster (*Aster lentus*) (2)[1]
hispid bird's-beak (*Cordylanthus mollis* ssp. *hispidus*) (2)
recurved larkspur (*Delphinium recurvatum*) (2)
fragrant fritillary (*Fritillaria liliacea*) (2)
adobe lily (*Fritillaria pluriflora*) (2)
Contra Costa goldfields (*Lasthenia conjugens*) (1)[1]
delta tule-pea (*Lathyrus jepsonii* ssp. *jepsonii*) (2)
legenere (*Legenere limosa*) (2)
Mason's lilaeopsis (*Lilaeopsis masonii*) (2)
veiny monardella (*Monardella douglasii* var. *venosa*) (2)
valley sagittaria (*Sagittaria sanfordii*) (2)
Mission Delores campion (*Silene verecunda* ssp. *verecunda*) (2)
showy Indian clover (*Trifolium amoenum*) (2)
California linderiella (*Linderiella occidentalis*) (2)
Pacific western big-eared bat (*Plecotus townsendii townsendii*) (2)
greater western mastiff-bat (*Eumops perotis californicus*) (2)
spotted bat (*Euderma maculatum*) (2)
ferruginous hawk (*Buteo regalis*) (2)
white-faced ibis (*Plegadis chihi*) (2)
loggerhead shrike (*Lanius ludovicianus*) (2)
California tiger salamander (*Ambystoma californiense*) (2■)[1]
Western spadefoot toad (*Scaphiopus hammondi hammondi*) (2R)[1]
Northwestern pond turtle (*Clemmys marmorata marmorata*) (2)
Green sturgeon (*Acipenser medirostris*) (2R)
Longfin smelt (*Spirinchus thaleichthys*) (2)
Sacramento Valley tiger beetle (*Cicindela hirticollis abrupta*) (2R)

Plants. Habitat for the palmate-bracted bird's beak, a federally endangered species, consists primarily of alkaline valley and foothill grassland, and chenopod scrub in which saltbush and greasewood frequently dominate. It is mostly found on alkaline soils and blooms in May-October. This plant is threatened by agricultural conversion, urbanization, and altered hydrology (Smith and Berg 1988).

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1 This nomenclature is fully defined in the listed and proposed endangered and threatened species list contained in Appendix D.

Solano grass, a federally endangered species, is a small, summer-blooming annual grass. It grows from 2 to 20 centimeters high. Its morphological distinctness and evolutionarily distance from all other grasses (USFWS 1994) suggest that the family Orcuttieae constitutes an ancient, relict tribe of grasses that perhaps was more widely distributed around the lakes and marshes that mantled most of the Central Valley in the recent geologic past. Most known populations of Orcuttieae, however, occur on relatively recently deposited lake bed soils suggesting recent origin or diversification. Orcuttieae, along with numerous other genera, compose taxa that have radiated extensively in the vernal pools of California (USFWS 1994).

Colusa grass, a federally proposed threatened species, is a vernal pool obligate, and endemic to California. It is found in valley clay pan soils and in saline alkaline basins. In upland habitats, these plants are found in fans and terraces, from 100 to 4,500 feet in elevation. This is a very rare plant which lacks legules (Fuller 1994 pers. comm.).

Slender orcutt grass, a federally proposed threatened species, is a weakly tufted, sparsely hairy annual grass. It grows from 2 to 6 inches in height (USFWS 1994) and blooms between May and July (Munz and Keck 1968). It is found on the bottom of dried vernal pools on volcanic soils in open grasslands and blue oak woodlands from Shasta County to Sacramento County in northern California. It is often found with other vernal pool plants such as spikerush (*Elcocharis* spp.) and coyote thistle (*Eryngium* spp.) (USFWS 1994).

Hartweg's golden sunburst, a federally proposed endangered species, is generally found on low rolling hills in valley grassland. All of the sites located for this plant have been associated with Mima mound topography, which is often associated with nearby vernal pools. Hartweg's golden sunburst is found predominantly on the northern slopes of knolls, but also along shady creeks, or near vernal pools with clay soils, between 50 to 460 feet in elevation (Stebbins 1991).

Birds. The bald eagle, a federally threatened species, is a resident, and is also known to migrate through, and winter in, California. It feeds mainly on fish, but will also eat water birds and mammals. It perches high in large, stoutly limbed trees, on snags or broken-topped trees, or on rocks near water. It requires large bodies of water, or free-flowing rivers with abundant fish, and adjacent snags or other perches. The bald eagle breeds in February through July, peak activity is March to June, and 87 percent of nest sites are located within 1 mile of water. It is monogamous and breeds first at year 4 or 5, with an average clutch size of two eggs (Zeiner *et al.* 1990). Populations of bald eagles have seriously diminished in number due to shooting, pesticides, and human encroachment.

The American peregrine falcon, a federally endangered species, is an uncommon breeding resident and an uncommon migrant to California. Important yearlong habitats include riparian areas, and coastal and inland wetlands. Protected cliffs and ledges are needed for cover. It breeds in woodlands, forests, and coastal habitats and the breeding period is from early March to late August (Zeiner *et al.* 1990). It is not known to nest in the proposed project area, however, falcons may occasionally be found foraging in the area in the fall and winter months. Peregrine falcons eat a variety of birds, mammals, fish, and insects (Zeiner *et al.* 1990).

The Aleutian Canada goose, a federally threatened species, is a subspecies of the Canada goose. Preferred habitats include lacustrine, fresh emergent wetlands, moist grasslands, croplands, pastures, and meadows. It feeds on green shoots, seeds, wild grasses, forbs, and aquatic plants. It nests mainly from March to June and prefers to nest near water on a dry, slightly elevated site, with good visibility from the nest (Zeiner *et al.* 1990). It will also

use man-made structures such as platforms, baskets, and artificial rock islands (Zeiner *et al.* 1990).

Reptiles. The giant garter snake, a federally threatened species, inhabits sloughs, ponds, small lakes, low gradient streams, and other waterways, such as irrigation and drainage canals. It feeds primarily on small fishes and frogs. Some habitat requisites consist of adequate water during the snake's active season (early spring through mid-fall) to provide food and cover, and emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season. The giant garter snake inhabits small mammal burrows throughout its winter dormancy period (November to mid-March). The breeding season extends through March and April, and females give birth to live young from late July through early September. Clutch size is variable, ranging from 10 to 46 young. Urban expansion, flood control projects, and other human activities currently threaten the survival of this snake throughout its range (USFWS 1991a).

Fish. The winter-run chinook salmon, a federally endangered species, is a unique population of chinook salmon that spawns in the Sacramento River and is distinguishable from other chinook salmon runs found in the river based on the timing of its upstream migration and spawning season. Flow modification, water diversions, and loss of spawning and rearing habitat are thought to be major factors contributing to the decline of the winter-run chinook salmon. Currently, about 95 percent of winter-run chinook salmon spawning occurs between Keswick Dam and Red Bluff Diversion Dam; the remainder occurs downstream of Red Bluff Diversion Dam (NMFS 1992).

The delta smelt, a federally-listed threatened species, is a slender-bodied translucent planktivorous fish known to occur in the San Francisco Bay Estuary. It is the only true native estuarine fish in the Estuary (Moyle *et al.* 1992). Delta smelt typically have a 1 year life span. Adults enter dead-end sloughs and channel edge-waters of the Delta to spawn between about February and June. Spawning occurs in open waters, and the adhesive, demersal eggs attach to hard substrates such as rocks, tree roots, gravel, and submerged branches and vegetation. Fecundity is low, usually ranging between 1,400 and 2,800 eggs per female. Adults typically die after spawning. Eggs hatch in 10 to 14 days, and the planktonic larvae and juveniles are transported downstream to the estuarine mixing zone that, depending on outflow, may be located from Suisun Bay to the confluence of the Sacramento and San Joaquin Rivers. Juveniles also feed on zooplankton.

Although the delta smelt was one of the most common fish in the Delta as recently as the 1970s, it has undergone roughly a ten-fold decline in the past 10 years (from several million to several hundred thousand). Consequently, in 1993 the smelt was listed as threatened under the Federal Endangered Species Act. Factors which are believed to have contributed to the decline in population are: 1) low Delta outflow that results in (a) placement of the mixing zone upstream within the "zone of influence" of the Central Valley Project/State Water Project pumps, and (b) reductions in the geographic distribution of the smelt; 2) acute toxicity caused by influences of irrigation drain water; and 3) competition for food sources with recently introduced species such as the inland silverside (*Menidia beryllina*) and the Asiatic clam (*Potamocorbula amurensis*).

The Sacramento splittail, a federally proposed threatened species, is a large (up to 40 cm) minnow endemic to California's Central Valley. The species has been restricted to a small portion of its former range (Moyle *et al.* 1994) and is now found primarily in the Sacramento River and Sacramento-San Joaquin Delta, Suisun Bay, Suisun Marsh, and Napa Marsh.

The splittail is easily distinguished from other minnow species by the enlarged upper lobe of its caudal fin. It is tolerant of brackish water

conditions, and can often be found in Suisun Bay, San Pablo Bay, and the Carquinez Strait following winter high-flow periods, when waters in these areas are relatively diluted. Splittail feed primarily upon benthic invertebrates. Spawning requirements appear to be similar to those of delta smelt, in that both species congregate for spawning in the dead-end sloughs of the Delta. Splittail apparently spawn on flooded streambank vegetation or on beds of aquatic plants (Moyle 1976).

The decline in splittail abundance coincides with hydrologic changes to the Sacramento-San Joaquin Estuary. These changes include increases in water diversions during the spawning period of January through July, and dams that limit upstream migration. Diversions, entrainment due to Central Valley Project/State Water Project pumping, dams, and reduced outflow, coupled with years of severe drought, introduced aquatic species, and loss of wetlands and shallow-water habitat (CDFG 1992), appear to have reduced the species capacity to reverse its decline.

Invertebrates. The valley elderberry longhorn beetle (VELB), a federally threatened species, has been found only in association with its host plant, elderberry. Adults feed on the foliage and perhaps flowers, and are present from March through early June. In the spring the beetles mate, and the females lay eggs on living elderberry plants. After transforming into an adult within the plant, the beetle chews an exit hole and emerges from the elderberry. Elderberry shrubs and trees with VELB populations occur in a variety of habitats and plant communities, but most often in riparian or savanna areas (USFWS 1991b).

The vernal pool fairy shrimp, a federally threatened species, inhabits ephemeral pools. Nearly all fairy shrimp feed on algae, bacteria, protozoa, rotifers, and bits of detritus. The females carry the eggs in an oval or elongate ventral brood sac. The eggs are either dropped to the bottom or remain attached until the female dies and sinks. The thick-shelled "resting" or "winter" eggs are capable of withstanding high heat, cold, and prolonged desiccation. The eggs hatch when the vernal pools and swales fill with rainwater. The early stages of the fairy shrimp develop rapidly into adults (USFWS 1992).

Habitat for the vernal pool tadpole shrimp, a federally endangered species, consists entirely of vernal pools. Food items include organic detritus and living organisms that they capture, such as fairy shrimp and other invertebrates. Like the vernal pool fairy shrimp, the tadpole shrimp passes the dry months in the egg stage, and hatches when the pools are filled with rainwater (USFWS 1992).

FUTURE CONDITIONS WITHOUT THE PROJECT

Vegetation

No change in vegetation is expected on lands currently within project levees. Vegetation on the project levees is expected to be maintained as today. The grassland and grassland/orchard habitats on the landward side of the levees, beyond the levee toes, are not expected to change significantly; however, some existing grassland areas and scattered trees may be converted to orchard. Most of the orchards in the project impact area are young and just entering prime production age. The older orchards are likely to be replanted as their production declines.

The existing levees in the project area will require regular maintenance. However, these activities would not alter the present cover types or their overall habitat values. Existing agricultural acreage and patterns would remain stable in the vicinity of the proposed work areas.

Wildlife

Since no significant changes are expected in vegetation and cover-types, wildlife populations in the project area are expected to remain the same. However, normal year-to-year population fluctuations of individual species would be expected to continue as now.

Fish

The fish resources of the Sacramento and Feather Rivers, Sutter and Yolo Bypasses, and Knights Landing Ridge Cut are not expected to change significantly from existing conditions. We assume that any adverse impacts to anadromous fish by future Federal or State projects on these watercourses would be fully mitigated.

Endangered Species

Since no significant changes are expected in vegetation and cover-types, endangered and threatened species populations in the project area are expected not to change. However, normal year-to-year population fluctuations of individual species would be expected to continue as now.

FUTURE CONDITIONS WITH THE PROJECT

Vegetation

Cover type acreage was planimetered from copies of blueline aerial photographs (1991), provided by the Corps, of the proposed worksites. Map scale is 1:4,800 (1"= 400') for most of the sites, and 1:12,000 (1"=1,000') for the remainder of the sites. Information on permanent, temporary, and new easements, provided by the Corps, was used to determine impact zones. Lands lost to levee enlargement would be subject to existing levee maintenance activities. Preliminary acreage figures developed by the Corps in 1991 (USACE 1991) indicated about 460 acres would be impacted. However, some areas have changed and been eliminated since the IAR was written. Therefore, cover-types and acreage that would currently be impacted from the proposed project are shown in Table 2; a summary is given in Table 3.

Toe drain and berm construction, levee crown restoration, slurry wall construction, lime treatment, interceptor trench drain construction, seepage stability berm construction, drainage ditch filling and relocation, and clearing for equipment access would adversely affect vegetation at all worksites. A total of 224.28 acres would be disturbed. Vegetative cover-types that would be adversely impacted by the project would include 8.24 acres of riparian woodland; 3.22 acres of scrub-shrub; 13.08 acres of emergent marsh; 0.05 acres of permanent wetland; and 199.69 acres of grassland/agriculture.

Impacts to grasses on the levee slopes and adjacent agricultural lands would be temporary; these areas would recover their habitat values within a short period after construction is completed (2 years). Also within the grassland/agriculture cover-type, a total of 73 individual trees and shrubs would be removed (worst-case scenario). Since these individual trees are widely scattered throughout the 18.27 miles of levees which would be repaired, they were enumerated by reach, but not included as a specific cover-type. No woody vegetation losses were identified at construction staging areas or borrow sites since impacts to woody vegetation at these sites could be avoided by fencing or flagging them prior to initiation of construction activities (C. Gaines, pers. comm.). Terrestrial habitat losses at each site, in terms of Average Annual Habitat Units (AAHUs) and acres lost, are presented in Table 2; totals are presented in Table 3. For acres impacted, we assumed that the Corps would construct berms/drains rather than cutoff walls (least impact). No new cover types would be created by project work or associated mitigation measures. More detail is provided on the HEP analysis in Appendix F-6.

Three borrow sites would be needed to provide the volume of embankment material necessary for levee raising and for the landside toe berms. Borrow Site 1 consists of about 20.0 acres of sandy soils and grasses. Borrow Site 2 consists of about 48 acres of various vegetative species including grasses, daisies (Compositae family), cottonwood seedlings, cockelbur (*Xanthium strumarium*), mint (Labiatae family), and wild mustard. Borrow Site 3 consists of about 40 acres of a fallow field (thistle) and scattered trees (i.e., cottonwoods).

Wildlife

Construction of the project in riparian woodland, scrub-shrub, emergent marsh, and permanent wetland cover-types, would reduce the carrying capacity of these areas for wildlife, and eliminate valuable habitat which is already scarce in the project area. Impacts to the grassland/agriculture cover-type are expected to be temporary and habitat values would restore after construction is completed and the areas are reseeded. Therefore, wildlife use of this cover-type would only be temporarily impacted.

Table 2. Cover-types impacted, acres impacted, total AAHUs lost, and individual trees lost for the Sacramento River Flood Control System Evaluation, Phase III project.

SITE #	COVER-TYPE IMPACTED	ACRES IMPACTED	TOTAL AAHUs LOST[1]	INDIVIDUAL TREES LOST
1	Grassland/agriculture	0.09	--	0
2	Grassland/agriculture	0.12	--	0
2-1	Grassland/agriculture	0.01	--	0
2-2	Grassland/agriculture	0.01	--	0
2-3	Grassland/agriculture	0.01	--	0
2-4	Grassland/agriculture	0.01	--	0
2-5	Grassland/agriculture	0.01	--	0
2-6	Grassland/agriculture	0.01	--	0
2-7	Grassland/agriculture	0.01	--	0
2-8	Grassland/agriculture	0.01	--	0
2-9	Grassland/agriculture	0.01	--	0
2-10	Grassland/agriculture	0.01	--	0
3	Grassland/agriculture Emergent marsh	14.60 .05 14.65	-- 0	0
4	Grassland/agriculture	14.60	--	7
5	Emergent marsh Grassland/agriculture	0.73 4.41 5.14	0 --	9
6	Grassland/agriculture	12.67	--	0
7	Grassland/agriculture	10.19	--	0
9	Grassland/agriculture	1.93	--	0
10	Grassland/agriculture	1.38	--	33
11	Grassland/agriculture	5.51	--	7
12	Riparian woodland Emergent marsh Grassland/agriculture	5.69 7.39 30.74 43.82	4.69 0.18 -- 4.87	0
12A	Grassland/agriculture	10.33	--	0
13	Emergent marsh Grassland/agriculture	1.15 5.32 6.47	0.18 --	0
14	Grassland/agriculture	10.19	--	0
15A	Emergent marsh Grassland/agriculture	3.62 16.63 20.25	0.18 --	0
15B	Grassland/agriculture	51.24	--	0
17	Riparian woodland Permanent wetland Grassland/agriculture	0.68 0.05 1.84 2.57	0.56 0.01 -- 0.57	1
18	Riparian woodland Grassland/agriculture	1.87 0.70 2.57	1.56 --	3
19	Emergent marsh Grassland/agriculture	0.14 2.61 2.75	0 --	13
20	Scrub-shrub Grassland/agriculture	3.22 4.49 7.71	2.67 --	0
		TOTAL: 224.28	TOTAL: 10.03	TOTAL: 73

[1]No HEP was conducted on grassland/agricultural cover-types, as indicated by the two dashed lines (--).

Table 3. Summary of cover-types impacted, acres impacted, total AAHUs lost, and individual trees that would be lost from Sacramento River Flood Control System Evaluation, Phase III project.

COVER-TYPES IMPACTED (excludes borrow sites)	TOTAL ACRES IMPACTED	TOTAL AAHUs LOST	INDIVIDUAL TREES LOST
Grassland/agriculture	199.69	--	(from grasslands/ agriculture areas)
Emergent marsh	13.08	0.54	
Riparian woodland	8.24	6.81	
Scrub-shrub	3.22	2.67	
Permanent wetland	0.05	0.01	
	TOTAL: 224.28	TOTAL: 10.03	TOTAL: 73

Fish

The work proposed is for the levee crowns, landside levee slopes and levee toe areas; therefore, no adverse impacts to fishery resources would occur in the proposed project area.

Endangered Species

Plants. The palmate-bracted bird's beak is found in association with valley and foothill grassland. Since grasslands would be impacted by the project, it is possible this endangered plant could be affected. Surveys for this species should be conducted to determine its presence or absence in tbe project area. Solano grass, associated with lake bed soils and vernal pools, would likely not be affected, since no vernal pools are found in the impact zone. Colusa grass, a vernal pool obligate, and slender Orcutt grass, would also likely not be impacted by the project for the same reason as Solano grass. Hartweg's golden sunburst is found on low rolling hills in valley grassland, along shady creeks, or near vernal pools with clay soils. Since neither creek or vernal pool habitat would be impacted by the project, it is unlikely that this species would be affected.

Birds. The winter range for the bald eagle includes the Central Valley, however, significant breeding, nesting, and roosting activities occur in the more northern and eastern counties of the state (i.e., Butte, Lake, Trinity). Although bald eagles may be found within the river systems of the project, it is not likely that they would be present in the project area. Thus, this species would not be significantly impacted by the project.

The American peregrine falcon is an uncommon breeding resident and an uncommon migrant to California. It is not known to nest in the proposed project area, however, as previously mentioned, falcons may occasionally be found foraging in the area in the fall and winter months. Therefore, other than through unlikely indirect impacts from disturbance due to construction activities if the bird happens to be foraging in the area, the peregrine falcon would not be impacted by the project.

The Central Valley is the main wintering ground of the Aleutian Canada goose (Zeiner *et al.* 1990). Preferred habitats include fresh emergent wetlands, croplands, and pastures, all of which are found in the proposed project area. The goose may be adversely affected by construction disturbances or the resultant habitat losses.

Reptiles. The giant garter snake is found in sloughs, ponds, small lakes, low gradient streams, and other waterways, such as irrigation and drainage canals. About 13.08 acres of irrigation ditches, some of which contain emergent marsh cover-type, would be impacted with the project, due to ditch relocation activities. Relocating any ditch containing the giant garter snake would be a direct impact to this reptile. We recommend that the Corps survey the drainage ditches at Sites 3, 12, 13, and 15A to determine the presence of

giant garter snakes. Specific recommendations will be made pending the results of the surveys.

Fish. Since the work proposed is for the levee crowns, landside levee slopes, and levee toe areas, no adverse impacts to winter-run chinook salmon, delta smelt, and Sacramento splittail would occur as a result of project construction.

Invertebrates. As discussed, the VELB has been found only in association with its host plant, the elderberry. Elderberry shrubs occur at Site 20. The number of stems which may be affected is currently being determined by the Corps. As discussed in the compensation guidelines for the VELB, the stems must be examined for exit holes to determine if the VELB is found in association with these shrubs. If the VELB is found at the site, coord ination with the Endangered Species section of the Service must take place, since it is possible the shrubs at this site, and therefore the VELB, could be directly impacted through levee repair activities.

The vernal pool fairy shrimp, California linderiella, and vernal pool tadpole shrimp inhabit vernal pools. Therefore, since no vernal pool habitats would be impacted with the proposed project, these invertebrates would not be impacted.

FISH AND WILDLIFE SERVICE MITIGATION POLICY AND RESOURCE CATEGORY DETERMINATION

General Policy

The recommendations herein for mitigation and the protection of fish and wildlife resources conform with the Service's Mitigation Policy as published in the Federal Register (46:15 January 23, 1981). The Mitigation Policy provides Service personnel with guidance in making recommendations to protect, conserve, and enhance fish and wildlife resources. The policy helps ensure consistent and effective Service recommendations, while allowing agencies and developers to anticipate Service recommendations and plan early for mitigation needs. The intent of the policy is to ensure protection and conservation of valuable fish and wildlife resources.

Under the Mitigation Policy, resources are assigned to one of four distinct Resource Categories, each having a mitigation planning goal which is consistent with the fish and wildlife habitat values involved. The Resource Categories cover a range of habitat values from those considered to be unique and irreplaceable to those believed to be much more common and of relatively lesser value to fish and wildlife.

In applying the Mitigation Policy during an impact assessment, each specific habitat or cover-type which may be impacted by the project is identified. Evaluation species which utilize each habitat or cover-type are then selected for Resource Category determination. Selection of evaluation species can be based on several rationales, including: (1) species known to be sensitive to specific land and water use actions; (2) species that play a key role in nutrient cycling or energy flow; (3) species that utilize a common environmental resource; or (4) species that are associated with important resource problems, such as anadromous fish and migratory birds, as designated by the Director or Regional Directors of the Service. Evaluation species used for Resource Category determinations may or may not be the same evaluation elements used in an application of the Service's Habitat Evaluation Procedures (HEP), if one is conducted. Finally, based on the relative importance of each specific habitat to its selected evaluation species, and the habitat's relative abundance, the appropriate Resource Category and associated mitigation planning goal are determined.

Mitigation goals range from "no loss of existing habitat value" (Resource Category 1) to "minimize loss of habitat value" (Resource Category 4). The goal for Resource Category 2 is "no net loss of in-kind habitat value"; to achieve this goal, any unavoidable losses of habitat value would need to be replaced in-kind. As defined in the Mitigation Policy, "in-kind replacement" means providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate those lost.

In addition to mitigation goals based on habitat values as defined according to Resource Categories in the Mitigation Policy, Region 1 of the Service has a goal of "no net loss of wetland *acreage* or habitat *values*, whichever is greater." The Service applies this goal for all proposed Federal and non-Federal water development or flood control activities in California that may affect wetlands habitats.

In recommending mitigation for adverse impacts to any of these habitats, the Service uses the same sequential mitigation steps recommended in the Council on Environmental Quality's regulations. These mitigation steps (in order of preference) are: avoidance, minimizing, rectification measures, measures to reduce or eliminate impacts over time, and compensation measures.

Resource Category Determination

Five cover-types would be impacted by the proposed project: 1) riparian woodland; 2) scrub/shrub; 3) emergent marsh; 4) permanent wetland; and 5) grassland/agricultural. Individual trees located at six of the sites would also be impacted.

The riparian woodland cover-type is composed of mixed trees and shrubs with an overstory generally 16 feet or greater in height. Three riparian woodland communities form on low terrace sites: mature cottonwood forest, mixed riparian herb/scrub, and alder-willow. Mature cottonwood forests develop from young willow-cottonwood forests. A mid-story of black walnut, box elder, and willow is typical if dense herb-vine growth is not present. Smaller trees and shrubs, such as elderberry, willow, and wild rose, are typically found in the understory. High terrace communities are developed from mature cottonwood forests, as terrace elevations increase and cottonwoods senesce and die releasing the mid-story trees from inhibition of over-story shading. High terrace communities are inundated only during peak storm runoff events and are usually not subject to severe physical battering, erosion, or long-term flooding. In some instances, these communities have been isolated from flooding due to construction of flood control features such a levees. The high terrace riparian forests are one of the rarest communities in the Sacramento Valley relative to historical extent. This is primarily related to its attraction for urban and agricultural development due to high soil fertility and water infiltration rates, and low flood frequency. Nesting raptors, such as Swainson's and red-tailed hawks, were selected to represent the values of the riparian woodland cover-type. Raptors were selected because of a) their ability to represent other riparian-oriented birds; b) their importance for non-consumptive human uses (e.g., bird-watching); and c) Service responsibilities for their management under the Migratory Bird Treaty Act (i.e., Swainson's hawk). These raptors require large trees, usually cottonwoods, sycamores, or oaks, in riparian areas for nesting. These habitat cmponents have been reduced significantly in the project area and surrounding lands due to urbanization, agricultural conversion, land reclamation, and fragmentation and disturbance of existing habitat. Riparian habitat has decreased to 2 percent from historic levels within the state. However, the existing riparian forests of the Sacramento River are of extremely high value to the evaluation species, primarily because they are the only areas which meet their primary life requisites. Accordingly, the Service finds that riparian woodland cover-type that would be impacted by the project should have a mitigation planning goal of no net loss of in-kind habitat value or acreage (i.e., Resource Category 2).

The scrub/shrub cover-type identified in this project is defined as mixed trees and shrubs averaging less than 16 feet tall. Typical species of this cover-type within the project area are small oaks, cottonwoods, elderberries, and wild rose. Migratory songbirds, such as the northern oriole and yellow warbler, were selected to represent the values of the scrub/shrub cover-type because of a) their value as indicator species for many other birds which use the scrub-shrub cover-type in the project area; b) their importance for non-consumptive human uses (e.g., bird-watching); and c) Service responsibilities for their management under the Migratory Bird Treaty Act. Many songbirds utilize this cover-type on the Sacramento River for cover, nesting and feeding (see Appendix B). Insects present in these areas provide an abundant food source for numerous species. The extent of this cover-type has been severely reduced due to agricultural and urban development and it is now relatively scarce in the project area and surrounding lands. Therefore, in accordance with the Mitigation Policy, the current scarcity of scrub/shrub habitat in the project area, and its high value to migratory songbirds, the Service finds that scrub-shrub habitat that would be impacted by the project should have a mitigation planning goal of no net loss of in-kind habitat value or acreage (i.e.,Resource Category 2).

The emergent marsh cover-type is defined as areas with wetland vegetation emerging from the water surface. In the project area, this cover-type is found within seasonal drainage ditches; typical species include cattail and bulrushes. The evaluation species selected to represent the value of this cover-type is the great egret because of a) its value as an indicator species for other birds which use the emergent marsh cover-type; and b) its importance for non-consumptive human uses (e.g., bird-watching). Emergent marshes provide food, cover, and water for great egrets. The extent of emergent wetlands in the project area has been severely reduced due to flood control projects and subsequent reclamation for agriculture and urban uses. As a result of its high value to the evaluation species and its relative scarcity, the Service finds that emergent marsh habitat that would be impacted by the project should have a mitigation planning goal of no net loss of in-kind habitat value or acreage (i.e., Resource Category 2).

The permanent wetland cover-type, that would be impacted by the project, is found on the landside of the Feather River. It is characterized by open fresh water with margins of dense wetland vegetation, such as cattails and bulbrushes. The evaluation species selected to represent the value of this cover-type is a resident waterfowl, such as the mallard, because of a) its value as an indicator species for other birds which use permanent wetland cover-type; and b) their importance for consumptive and non-consumptive human uses (e.g., hunting, bird-watching). The permanent wetland cover-type is an uncommon type in the project area, and very valuable as feeding, reproduction, and cover areas to numerous wildlife species because of wetland scarcity. Within the project area, existing permanent wetlands often provide the only suitable habitat for wetland species during some times of the year. As a result of its high value to the evaluation species and its relative scarcity, the Service finds that permanent wetland habitat that would be impacted by the project should have a mitigation planning goal of no net loss of in-kind habitat value or acreage (i.e., Resource Category 2).

The grassland/agricultural cover-type contains several varieties of grasses, forbs, and weeds. Some areas also support woody tree species. The evaluation species selected to represent the value of this cover-type are small mammals, such as the California ground squirrel (*Citellus beecheyi*), and the California vole (*Microtus californicus*). Small mammals were chosen because of their value as indicator species for other animals which utilize grassland/agricultural habitat in the project area. The grassland/agricultural cover-type is the most common type in the project area, yet is valuable to some wildlife species. This cover-type typically supports the small mammal prey-base for larger mammals and raptors. Within the project area, grasslands containing scattered trees are important perching areas for some foraging raptors. The Service finds that grassland/agricultural habitat that would be impacted by the project should have a mitigation planning goal of no loss of habitat value while minimizing loss of in-kind habitat value (i.e., Resource Category 3).

The above cover-types, their evaluation species, resource category determinations, and associated mitigation goals are summarized in Table 4.

Table 4. Evaluation species, Resource Categories, and mitigation planning goals for the cover-types found within the Sacramento River Flood Control System Evaluation, Phase III project area.

COVER-TYPE	EVALUATION SPECIES	RESOURCE CATEGORY	MITIGATION GOAL
Riparian woodland	Nesting raptors	2	No net loss of in-kind habitat value or acreage
Scrub-shrub	Migratory songbirds	2	No net loss of in-kind habitat value or acreage
Emergent marsh	Great egret	2	No net loss of in-kind habitat value or acreage
Permanent wetland	Waterfowl	2	No net loss of in-kind habitat value or acreage
Grassland/Agricultural	Small mammals	3	No loss of habitat value while minimizing loss of in-kind habitat value

MITIGATION

Three potential compensation sites were identified: **Mitigation Site 1** (60.0 acres) is located in the Sutter Bypass near the confluence of the Feather and Sacramento Rivers, (Figure 5) near the Sacramento Slough. It is composed of fallow fields containing weeds and is surrounded by riparian forest. Mitigation Site 1 is our preferred site due to its location, access, and management potential. **Mitigation Site 2**, (70.0 acres) is located in the Sutter Bypass (Figures 6 and 7), along the Sacramento River between River Mile 84.0 and the East Canal, just north of Gray's Bend. This site currently is farmed for safflower. **Mitigation Site 3**, (17.0 acres) is located in the Sutter Bypass south of the Sacramento Slough along the East Canal (Figure 8). It is located near Sacramento River Mile 83.0 and currently supports a jajoba crop. Figure 9 shows all three potential mitigation sites.

A single compensation scenario, using Mitigation Site 1, was evaluated to replace the riparian woodland, scrub-shrub, and permanent wetland cover-types that would be lost with the project. This scenario involves the acquisition, development, and management of a compensation area, preferably adjacent to the Sacramento or Feather Rivers. Since all of the sites currently have a HSI value of 0.0 for the HEP evaluation species (see HEP report, Appendix F), any or a combination of sites could theoretically be used to compensate for unavoidable adverse impacts of the project. Habitat values and acreages lost, for each cover-type, would be replaced on the site(s) by preparing the sites, replanting, and ensuring the successful establishment of the desired cover-type vegetation.

The acquisition of lands for mitigation has become quite difficult, and what would actually be acquired would depend on what is available with the desired criteria when the acquisition stage is reached. Because it is unknown whether Mitigation Site 1 would be acquired, the reader can assume it is a hypothetical site, with the elements the Service would recommend the Corps use for compensation. A similar site, if it could be purchased, would presumably be acceptable, but would need to be approved by the Service.

<u>Riparian Woodland</u>. With the project, 5.69 acres of riparian woodland would be impacted at Site 12, 0.68 acres would be impacted at Site 17, and 1.87 acres would be impacted at Site 18, resulting in a total acreage of 8.24. HEP results (Table 5 and Appendix F) showed that the impacts would be fully compensated by replanting 11.74 acres of riparian vegetation at a suitable compensation site (Mitigation Site 1). Table 6 gives a summary of cover-types impacted, acres impacted, total AAHUs gained, acres needed for compensation, and number of trees required to be planted for compensation.

Development of the site would involve the planting of various riparian tree species including Fremont cottonwoods, valley oaks, and willows. The species mix and density should be sufficient to establish 60 to 80 percent canopy cover by the end of the 52-year period of analysis. Plantings can be obtained from local stock through cuttings and seeds, and grown at a local commercial nursery. All plantings would require watering, weed control, protection from predation, and appropriate replacement of dead or dying plantings. Watering and maintenance should be required until the plants were self-sufficient and capable of self-regeneration.

A 20-year monitoring period beyond the establishment period would be required to determine the long-term success of the plantings and the overall mitigation effort. Monitoring would be required on a fixed schedule, such as every year for the first 5 years of the 20-year period, and then every 5 years thereafter. If, within the monitoring period, revegetation efforts are determined to be unsuccessful in meeting criteria established for the site,

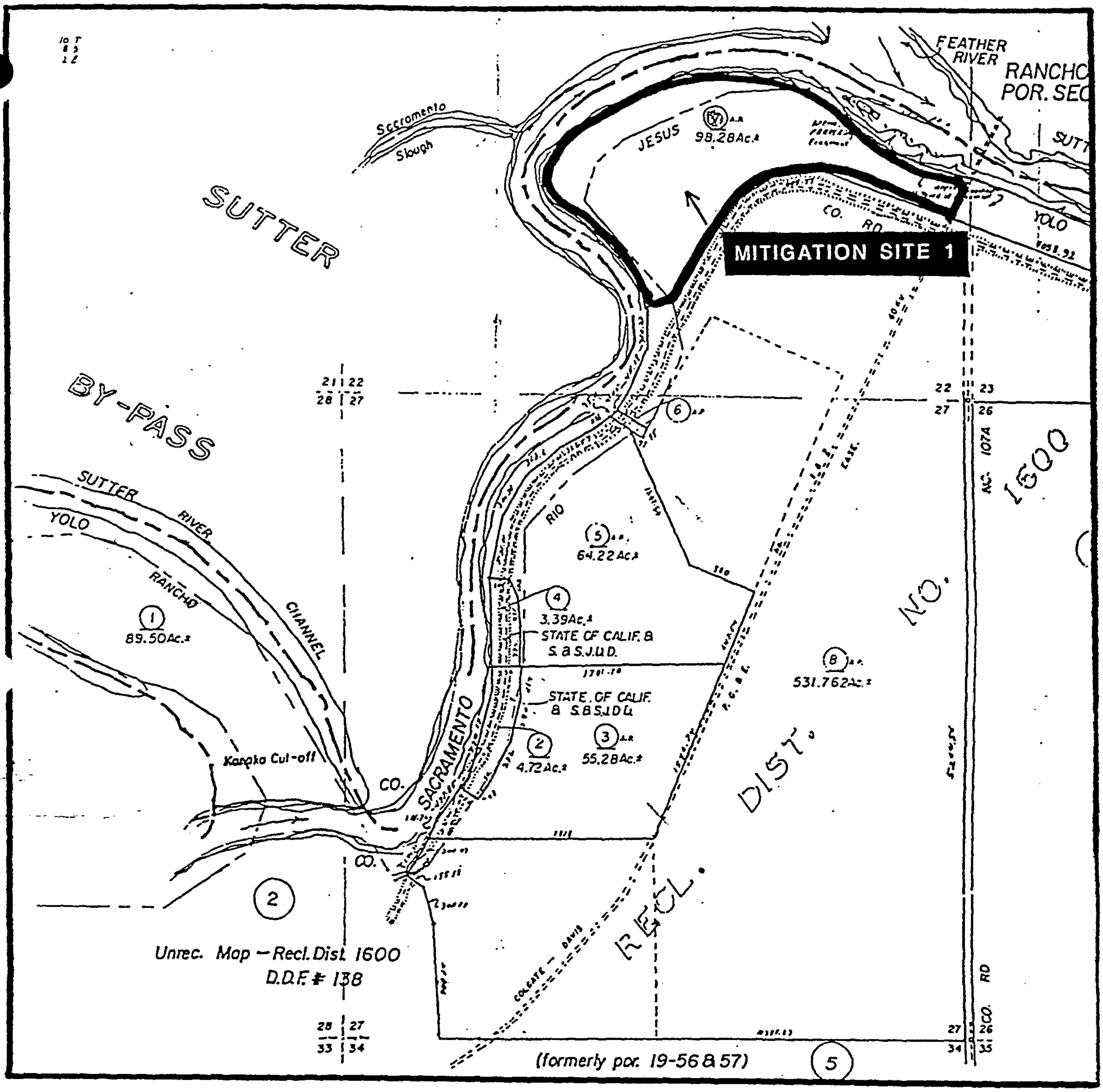

Figure 5. Mitigation Site 1 location for the Sacramento River Flood Control System Evaluation, Phase III project.

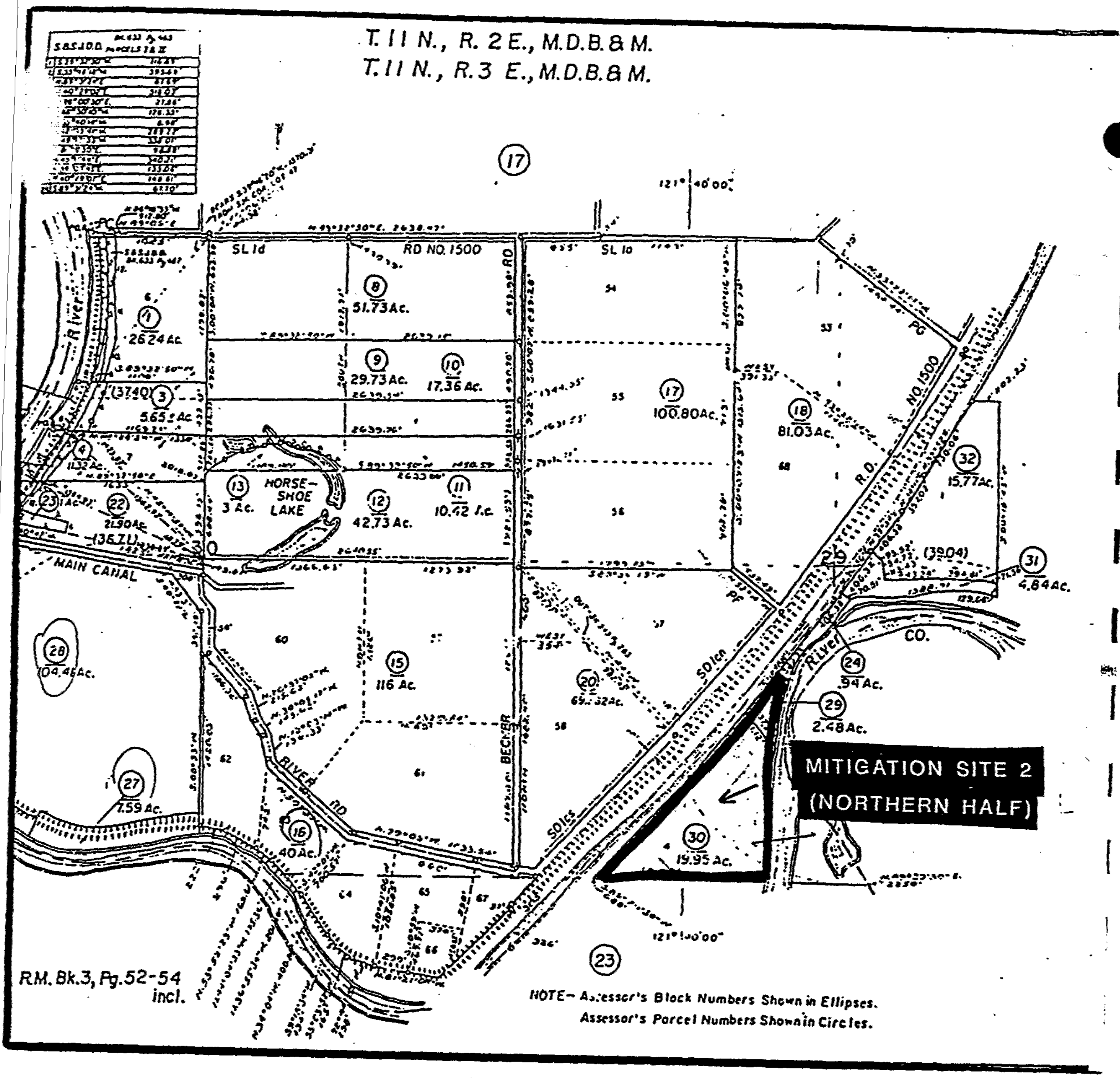

Figure 6. Mitigation Site 2 (northern half) location for the Sacramento River Flood Control System Evaluation, Phase III project.

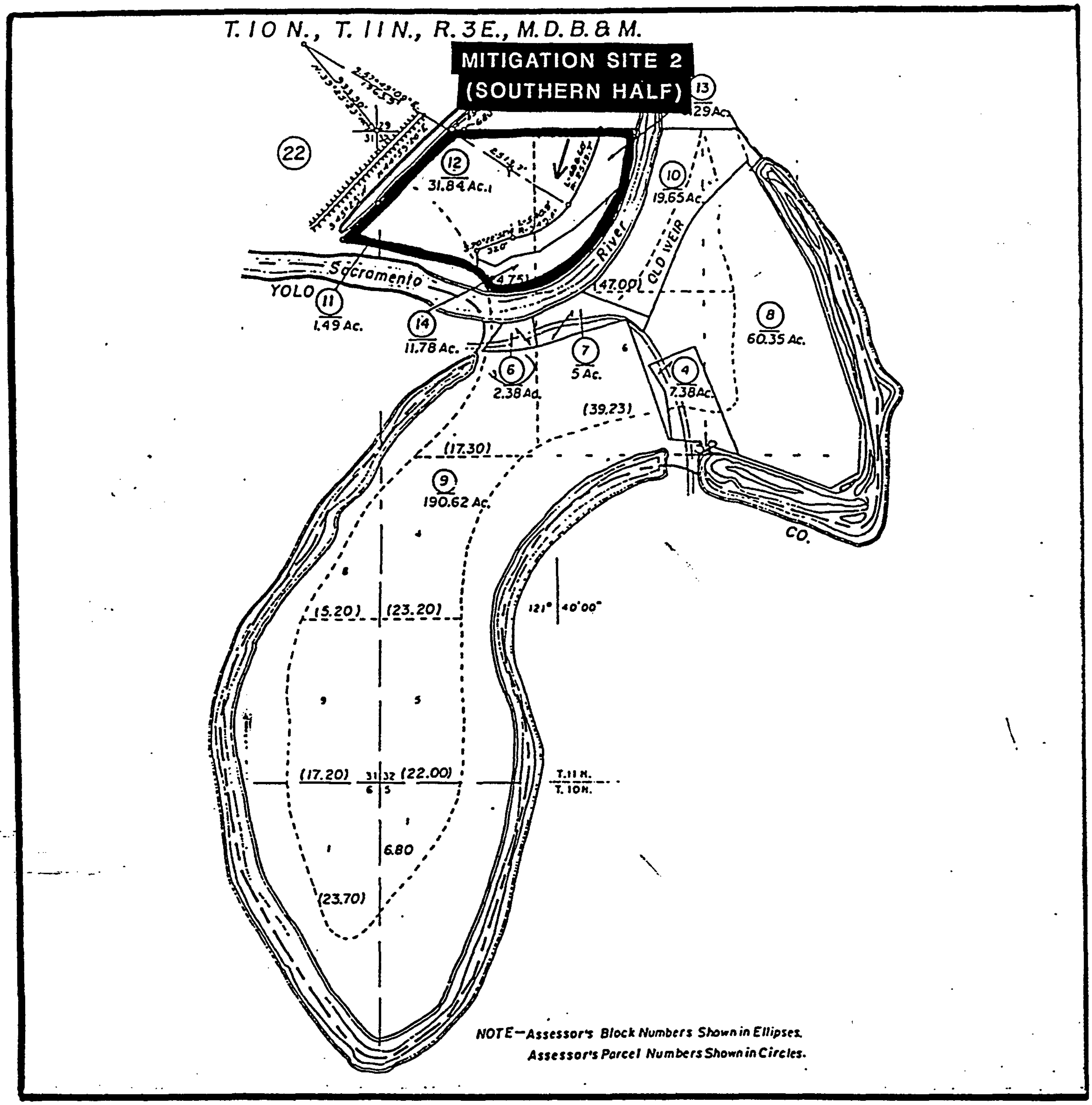

Figure 7. Mitigation Site 2 (southern half) location for the Sacramento River Flood Control System Evaluation, Phase III project.

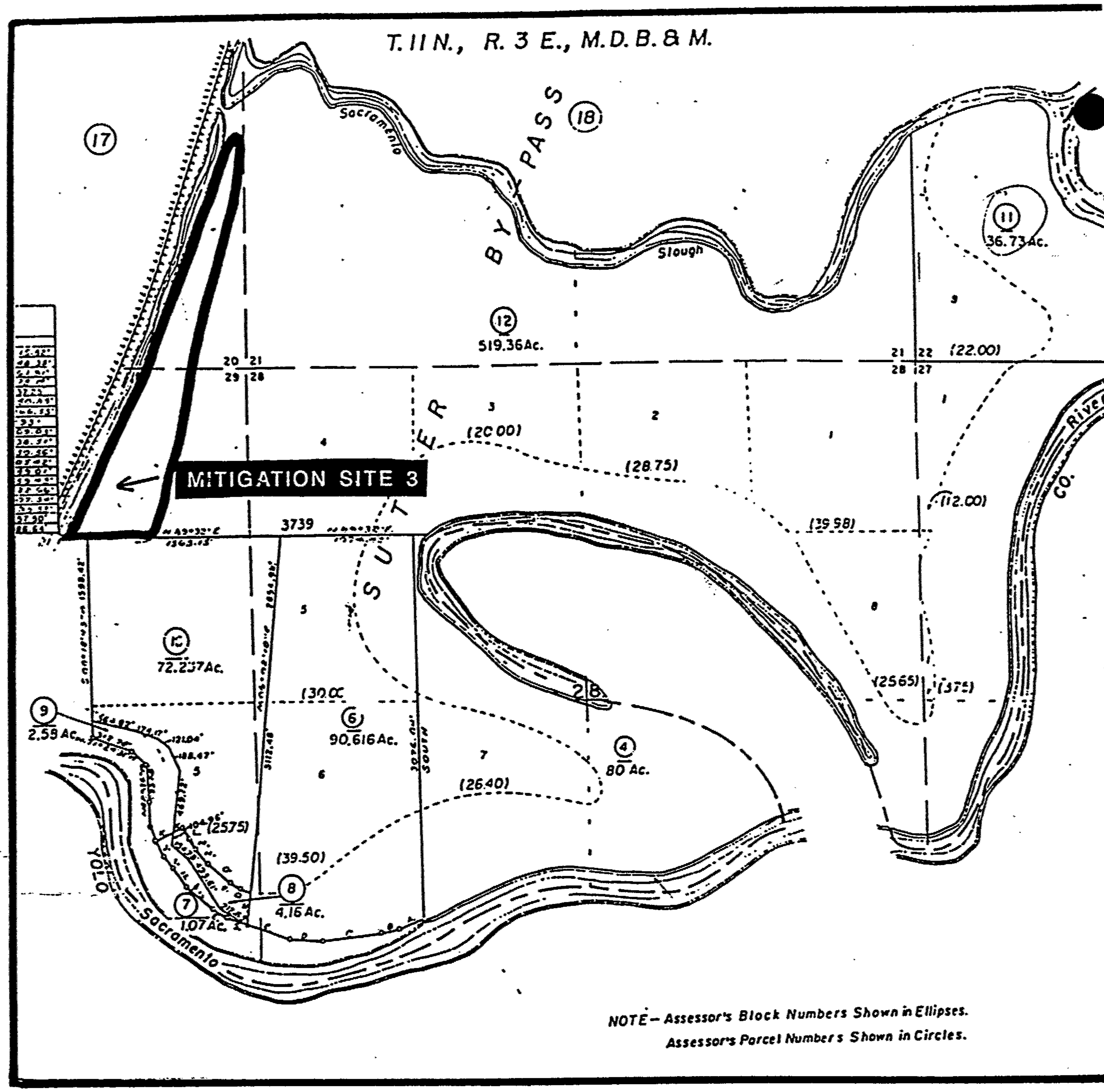

Figure 8. Mitigation Site 3 location for the Sacramento River Flood Control System Evaluation, Phase III project.

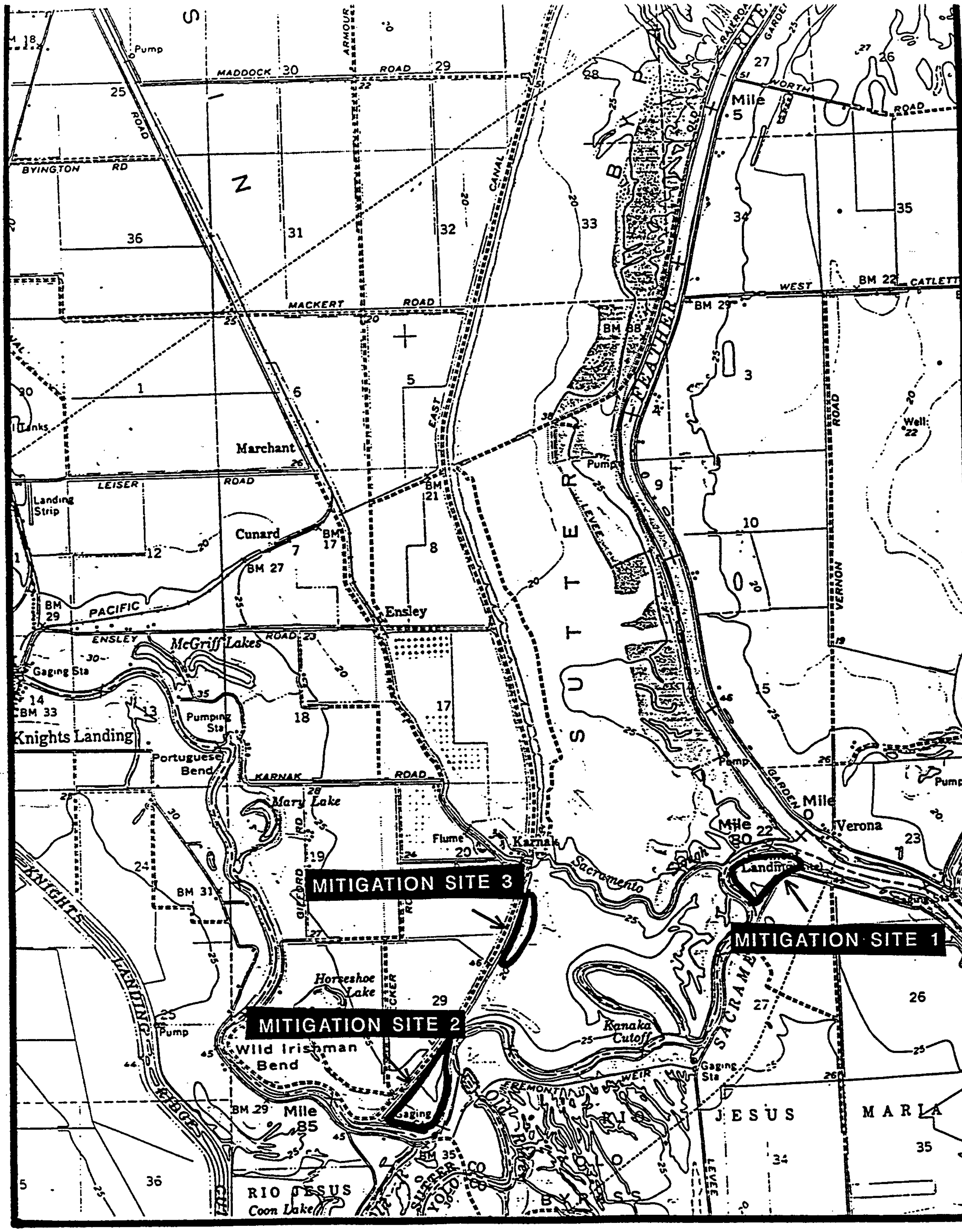

Figure 9. Mitigation Sites 1, 2, and 3 locations for the Sacramento River Flood Control System Evaluation, Phase III project.

Table 5. Compensation needs for the proposed worksites for the Sacramento River Flood Control System Evaluation, Phase III project.

SITE #	COVER-TYPE IMPACTED	COMPENSATION ACREAGE	TOTAL AAHUs GAINED	NO. OF TREES TO PLANT
1	Grassland/agriculture	0	--	0
2	Grassland/agriculture	0	--	0
2-1	Grassland/agriculture	0	--	0
2-2	Grassland/agriculture	0	--	0
2-3	Grassland/agriculture	0	--	0
2-4	Grassland/agriculture	0	--	0
2-5	Grassland/agriculture	0	--	0
2-6	Grassland/agriculture	0	--	0
2-7	Grassland/agriculture	0	--	0
2-8	Grassland/agriculture	0	--	0
2-9	Grassland/agriculture	0	--	0
2-10	Grassland/agriculture	0	--	0
3	Emergent marsh Grassland/agriculture	0.05 0	4.33 --	0
4	Grassland/agriculture	0	--	35
5, 19	Emergent marsh Grassland/agriculture	0.87 0	2.60 --	45
6	Grassland/agriculture	0	--	0
7	Grassland/agriculture	0	--	0
9	Grassland/agriculture	0	--	0
10	Grassland/agriculture	0	--	165
11	Grassland/agriculture	0	--	35
12 12, 13, 15A 12	Riparian woodland Emergent marsh Grassland/agriculture	8.08 12.36 0 20.44	6.97 23.37 -- 30.34	0
12A	Grassland/agriculture	0	--	0
13	Grassland/agriculture	0	--	0
14	Grassland/agriculture	0	--	0
15A	Grassland/agriculture	0	--	0
15B	Grassland/agriculture	0	--	0
17	Riparian woodland Permanent wetland Grassland/agriculture	0.97 0.05 0 0.98	1.16 0.44 -- 1.60	5
18	Riparian woodland Grassland/agriculture	2.69 0	2.32 --	15
19	Grassland/agriculture	0	--	65
20	Scrub-scrub Grassland/agriculture	4.59 0	3.49 --	0
		TOTAL: 29.66	TOTAL: 44.68	TOTAL: 365

Table 6. Summary of cover-types impacted, acres impacted, total AAHUs gained, acres needed for compensation, and number of trees required to be planted for compensation for the Sacramento River Flood Control System Evaluation, Phase III project.

COVER-TYPE IMPACTED	TOTAL ACRES IMPACTED	TOTAL ACRES NEEDED FOR COMPENSATION	TOTAL AAHUs GAINED	NUMBER OF TREES TO PLANT
Grassland/agriculture	199.69	--	--	(from grassland/agricultural areas)
Emergent marsh	13.08	13.28	30.30	
Riparian woodland	8.24	11.74	10.45	
Scrub-shrub	3.22	4.59	3.49	
Permanent wetland	0.05	0.05	0.44	
TOTAL	224.28	29.66	44.68	365

corrective action should be required until the revegetation goal is met. Annual progress reports would be submitted by the local project sponsor to the Corps, Service, and CDFG for each of the first 10 years of the monitoring period, and each fifth year thereafter.

Estimated costs to replace riparian vegetation were $25,000 per acre in 1993, excluding land acquisition and maintenance costs. Irrigation (drip system) would be required for a minimum of at least 6 years, or until the plantings are well established and self-sustaining. Any dead or decadent trees and shrubs would be replaced and maintained until well established.

__Scrub-shrub__. With the project, 3.22 acres of scrub-shrub habitat would be impacted at Site 20. HEP results show that project impacts would be fully compensated by establishing 4.59 acres of scrub-shrub habitat at Mitigation Site 1 (Table 5).

Development of the site would include the planting of various riparian scrub-shrub species including willows and box elders. The species would be planted at a density which would establish 60-80 percent canopy cover within 10 years. Costs have not yet been determined, but would be expected to be somewhat less than those stated for the riparian forest cover-type.

__Emergent marsh__. With the project, 0.05 acres would be impacted at Site 3; 12.16 acres would be impacted at Sites 12, 13 and 15A; and 0.87 acres would be impacted at Sites 5 and 19. The management plan would provide a net increase of 4.33 AAHUs for Site 3; 23.37 AAHUs for Sites 12, 13 and 15A; and 2.60 AAHUs for Sites 5 and 19. For Site 3, 0.05 acres would be needed for compensation; for Sites 12, 13, and 15A, 12.36 acres would be needed for compensation; and for Sites 5 and 19, 0.87 acres would be needed for compensation (Table 5). Although Site 5 was evaluated as emergent marsh cover-type, it contains a concrete-lined channel, and will be replaced at a ratio of 1:1. No AAHUs were lost at Site 5 or Site 19, which also contains no emergent marsh cover-type.

In accordance with the Service's mitigation policies in Region 1, there can be "no net loss of in-kind habitat value *or acreage*" (whichever is greater in acreage). For Site 3, the 0.05 acres required for full compensation could be replaced by relocating the ditch, and slightly expanding the acreage suitable for wetland vegetation establishment. The same could occur with sites 5 and

19. For Sites 12, 13 and 15A, 12.36 acres required for full compensation could be replaced at a ratio of 1:1.

The Service recommends enhancement whenever possible. The relocated drainage ditches could be enhanced to provide better habitat values than are currently present at the sites. This could be achieved by 1) widening the ditches to increase the overall habitat area; 2) maintaining the ditches at a specific water level range (4.0 to 6.0 inches); or 3) maintaining the substrate in the 4.0 to 9.0-inch-zone, to be covered by submerged or emergent vegetation (i.e., tules and cattails), at 30 to 60 percent.

Permanent wetland. One-half acre of lacustrine wetland exists at Site 17. With the project, about 0.05 acre of this habitat could be impacted. The Corps may be able to avoid the area, however, at this time we have analyzed the impact for a worst case scenario. The impact, if it occurs, would take place along the edge of the permanent pond where it borders the toe of the existing levee. The management plan (see Appendix F) developed for the site, would provide a net increase of 0.44 AAHUs. The loss of 0.05 acres (worst case), however, is insignificant in terms of overall acreage, but may involve a "take" of the giant garter snake. Should the giant garter snake be determined to be present, or suitable habitat be present, Section 7 consultation should be initiated.

Grassland/agriculture. Any loss of grassland habitat values due to project construction should be offset by seeding the disturbed areas and newly created berms with native grasses and forbs. Seeding should be conducted just prior to the rainy season. This would allow sufficient germination and establishment of these species. Estimated cost to reseed would be about $700/acre (per 1993 calculation).

Individual trees and shrubs. Any individual trees and shrubs within the grassland/agricultural areas removed along the landside toe of the levee and adjacent areas would require replacement. The trees provide important perching sites for raptors such as Swainson's and red-tailed hawks. They also provide cover for passerine birds, and valley oak and black walnut trees provide food for species such as the western gray squirrel. The shrubs provide cover for small mammals such as the black-tailed jackrabbit and California vole. Because of their value to various wildlife species within the proposed project area, mature trees and shrubs should be replaced at a ratio of at least 5:1. All plantings would require watering and maintenance for a minimum of 6 years. The most efficient watering method is the drip system. The loss of 73 scattered individual trees would be mitigated by planting 365 trees. All plantings would require watering, weeding, and protection from predation.

Tree species per site that could be impacted with the project are found in Table 7. Costs have not yet been determined.

Table 7. Tree species per site that may be removed by the Sacramento River Flood Control System Evaluation, Phase III project.		
SITE #	**NUMBER OF TREES**	**SPECIES OF TREES**
4	7	3 valley oaks, 4 black walnuts
5	9	5 cottonwoods, 2 ashes, 2 black walnuts
10	33	2 box elders, 12 black walnuts, 10 English walnuts, 1 cottonwood, 1 Oregon ash, 6 willows, 1 valley oak
11	7	2 valley oaks, 4 black walnuts, 1 English walnut
17	1	1 valley oak
18	3	3 valley oaks
19	13	13 valley oaks
	73	

RECOMMENDATIONS

The Service recommends that the Corps:

1. Avoid impacts to wildlife and their habitats from the proposed project by selecting the no-action alternative or modifying plans to avoid all impacts to riparian and wetland resources. If the project is pursued, however, implement recommendations #2-13.

2. Acquire a minimum of 16.33 acres at Mitigation Site 1 to compensate the adverse impacts on wildlife from construction alternatives to riparian woodland and scrub-shrub cover-types. Specifically, 11.74 acres of land should be acquired, developed, and managed as riparian woodland, and 4.59 acres of land should be acquired, developed, and managed as scrub-shrub. The 16.33 acres do not include impacts to emergent marsh, which would be mitigated for on-site through ditch relocations.

3. Implement at least a 20-year monitoring and remediation period to determine the success of the plantings and correct any failures of the mitigation effort. Monitoring and reporting should be required every year for the first 5 years of the 20-year period, and every 5 years afterward. If, within the monitoring period, revegetation efforts are unsuccessful, corrective actions would be required until mitigation goals are met. Funding sources for monitoring and remediation should be appropriated prior to project construction. A report of monitoring activities would be submitted by the local project sponsor to the Service, Corps, and Department. All phases of the revegetation and monitoring programs are to be coordinated with the Service, Corps, and Department.

4. Avoid all elderberry shrubs found at Site 20 by flagging each shrub prior to construction.

5. Compensate for losses to the elderberry shrubs at Site 20 (if they cannot be avoided as stated in recommendation #5) according to the most recent Fish and Wildlife Service compensation guidelines for the valley elderberry longhorn beetle. This should be coordinated with the staff of the Endangered Species section of the Service if it is determined that the VELB inhabits the elderberry stems.

6. Enhance sites where ditches will be relocated. Although the ditches will be relocated and replaced at about a ratio of 1:1, the Service also recommends that the emergent marsh cover-type be improved for wildlife use.

7. Reseed all areas where grassland/agricultural cover-types would be impacted, including levee slopes for erosion control. Native grasses and forbs should be used. Reseeding should be conducted just prior to the rainy season to enhance germination and plant establishment. Please refer to "Strategies for Establishing California Native Grasses" (Anderson 1994) for more information.

8. Preserve and protect scattered trees at Sites 4, 5, 10, 11, 17, 18, and 19, as well as at staging areas and borrow sites (if pertinent), by flagging each tree prior to construction activities. All woody vegetation at construction staging areas should be protectively fenced and field-inspected by the Service and Department prior to construction. All contractors and crew should be given verbal and written instruction to avoid these areas and made aware of the significant values of these areas to wildlife. In the event any woody vegetation is inadvertently destroyed at the staging areas, it should be replaced on-site at a ratio of 5:1. Watering and monitoring of replanting success, would be required until replanted areas are established, as determined by the Service and Department.

9. Preserve and protect riparian habitat at Site 12 by not relocating the part of the ditch where the trees are located.

10. Plant 365 trees at Mitigation Site 1 to compensate for the scattered trees that would be lost at Sites 4, 5, 10, 11, 17, 18, and 19 if they cannot be protected as stated in recommendation # 8 above.

11. The following recommendations are provided pursuant to Section 7 of the Endangered Species Act.

    a. To determine potential effects of the project on giant garter snakes, survey worksites 1, 2, 2-1 to 2-10, 3, 12, 12A, 13, 15A, 15B, and 17 to determine the presence of giant garter snakes in the drainage ditches and in the pond.

    b. Should the species be present, complete a Biological Assessment for the Project and determine whether the species would be affected.

    c. To reduce the likelihood of the species being adversely affected by the project, construct the new drainage ditches at Sites 3, 12, 13, and 15A prior to filling of the existing ditches. This work should be completed between mid-March and the end of October, when the snakes are most active and can escape construction impacts, as well as the work at Sites 1, 2, 2-1 to 2-10, 12A, 15B, and 17.

    d. Should the proposed action be likely to affect the giant garter snake or its critical habitat, initiate formal consultation with the Service.

12. Conduct site-specific surveys for Swainson's hawk nesting activity within 0.5 mile of all work sites during the season of, and prior to, the initiation of any construction. Several work sites are known to be near historical Swainson's hawk nesting areas. If hawks are found, the Service recommends that the Corps impose the appropriate seasonal moratorium which prohibits construction from March 15 until the young are no longer vulnerable to disturbance (up to about September 1). This recommendation should be coordinated with the Department, since the Swainson's hawk is a state-listed threatened species.

13. Reassess the overall design of the flood control system to use set-back levees wherever feasible. Confined levees found in much of the flood control system will not allow the restoration of self-sustaining riparian habitat areas.

14. Construct slurry walls wherever possible, instead of toe drains and berms, to minimize impacts to wildlife and its habitat, except in areas where there is potential to create a set-back levee system.

15. Contact the Service in a timely manner so that we can be involved in developing designs for the plans and specifications aspect of the project, in order to further help protect fish and wildlife in the proposed project area.

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APPENDIX A

PLANT SPECIES

APPENDIX A

Plant species found along the east side of Knights Landing Ridge Cut (Source: USACE 1992).

COMMON NAME	SCIENTIFIC NAME
False bamboo	*Arundo donax*
Wild oats	*Avena fatua*
Star thistle	*Centaurea solsititialis*
Goosefoot	*Chenopodium botrys*
Horseweed	*Conyza canadensis*
Love tangle	*Cuscuta* spp.
Queen Anne's lace	*Daucus carota*
Salt grass	*Distichlis spicata*
Fireweed	*Epilobium* spp.
Milk spurge	*Euphorbia maculata*
Alkalai heliotrope	*Heliotropium curassavicum*
Telegraph weed	*Heterotheca grandiflora*
California water primrose	*Ludwigia peploides*
Cheeseweed	*Malva parviflora*
Horsehound	*Marrubium vulgare*
Knotweed	*Polygonum aviculare*
Poplar	*Populus* spp.
Valley oak	*Quercus lobata*
Poison oak	*Rhus radicans*
Wild rose	*Rosa californica*
Willow	*Salix* spp.
Arroyo willow	*Salix lasiolepis*
Russian thistle	*Salsola iberica*
Tumbleweed	*Salsola kali*
Elderberry	*Sambucus* spp.
Tule	*Scirpus acutus*
Hedge mustard	*Sisymbrium orientale*
Goldenrod	*Solidago* spp.
Common mullein	*Verbascum thapsus*
California grape	*Vitis californica*
Cockleburr	*Xanthium strumarium*

APPENDIX B

BIRD SPECIES

APPENDIX B

Bird species seen along the Sacramento River. (This list represents a cumulation of observations over many years. Some species may be more commonly sighted than others, depending on time of year and populations of the species) (Source: USFWS 1976 *in* USFWS 1990).

COMMON NAME	SCIENTIFIC NAME
Common loon	*Gavia immer*
Arctic loon	*Gavia arctica*
Red-throated loon	*Gavia stellata*
Red-necked grebe	*Podiceps grisegena*
Horned grebe	*Podiceps auritus*
Eared grebe	*Podiceps nigricollis*
Western grebe	*Aechomophorus occidentalis*
Pied-billed grebe	*Popilymbus podiceps*
White pelican	*Pelecanus erythrorhynchos*
Double-crested cormorant	*Phalacrocorax auritus*
Great blue heron	*Ardea herodius*
Great egret	*Casmerodius albus*
Snowy egret	*Egretta thula*
Black-crowned night heron	*Nycticorax nycticorax*
Least bittern	*Ixobrychus exilis*
American bittern	*Botaurus lentiginosus*
White-fronted goose	*Anser albifrons*
Snow goose	*Chen caerulescens*
Ross goose	*Chen rossi*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
Pintail	*Anas acuta*
Green-winged teal	*Anas crecca*
Blue-winged teal	*Anas discors*
Cinnamon teal	*Anas cyanoptera*
American widgeon	*Anas americana*
Northern shoveler	*Anas clypeata*
Wood duck	*Aix sponsa*
Redhead	*Aythya americana*
Ring-necked duck	*Aythya collaris*
Canvasback	*Aythya valisineria*
Greater scaup	*Aythya marila*
Lesser scaup	*Aythya affinis*
Common goldeneye	*Bucephala clangula*
Barrow's goldeneye	*Bucephala islandica*
Bufflehead	*Bucephala albeola*
Ruddy duck	*Oxyura jamaicensis*
Hooded merganser	*Lophodytes cucullatus*
Common merganser	*Mergus merganser*
Turkey vulture	*Cathartes aura*
White-tailed kite	*Elanus leucurus*

COMMON NAME	SCIENTIFIC NAME
Goshawk	*Accipiter gentilis*
Sharp-shinned hawk	*Accipter striatus*
Cooper's hawk	*Accipiter cooperii*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
Swainson's hawk	*Buteo swainsoni*
Rough-legged hawk	*Buteo lagopus*
Ferruginous hawk	*Buteo regalis*
Golden eagle	*Aquila chrysaetos*
Bald eagle	*Haliaeetus leucocephalus*
Northern harrier	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Prarie falcon	*Falco mexicanus*
Peregrine falcon	*Falco peregrinus*
Merlin	*Falco columbarius*
American kestrel	*Falco sparuerius*
California quail	*Lophortyx californicus*
Ring-necked pheasant	*Phasianus colichicus*
Sandhill crane	*Grus canadensis*
Virginia rail	*Rallus limicola*
Sora	*Poranza carolina*
Common gallinule	*Callinula chloropus*
American coot	*Fulica americana*
Semipalmated plover	*Charadrius alexandrius*
Killdeer	*Charadrius vociferus*
Mountain plover	*Charadrius montanus*
American golden plover	*Pluvialis dominica*
Black-bellied plover	*Pluvialis squatorola*
Common snipe	*Capella gallinago*
Long-billed curlew	*Numenius americanus*
Whimbrel	*Numenius phaeopus*
Spotted sandpiper	*Actitis macularis*
Solitary sandpiper	*Tringa solitaria*
Willet	*Catoptrophorus semipalmatus*
Greater yellowlegs	*Tringa melanoleuca*
Lesser yellowlegs	*Tringa flavipes*
Baird's sandpiper	*Calidris bairdii*
Least sandpiper	*Calidris minutilla*
Dunlin	*Calidris alpina*
Long-billed dowitcher	*Limnodromous scolopaceus*
Western sandpiper	*Calidris mauri*
Marbled godwit	*Limosa fedoa*
American avocet	*Recurvirostra americana*
Black-necked stilt	*Himantopus mexicanus*
Herring gull	*Larus argentatus*
California gull	*Larus californicus*

COMMON NAME	SCIENTIFIC NAME
Mew gull	*Larus canus*
Bonaparte's gull	*Larus philadelphia*
Forster's tern	*Sterna forsteri*
Caspian tern	*Hydroprogne caspia*
Black tern	*Childonias niger*
Band-tailed pigeon	*Columba fasciata*
Rock dove	*Columba livia*
Mourning dove	*Zenaida macroura*
Barn owl	*Tyto alba*
Screech owl	*Otus asio*
Great horned owl	*Bubo virginianus*
Burrowing owl	*Speotyto cunicularia*
Long-eared owl	*Asio otus*
Short-eared owl	*Asio flammeus*
Saw-whet owl	*Aegolius acadicus*
Poorwill	*Phalaenoptilus nuttallii*
Lesser nighthawk	*Chordeiles acutipennis*
Vaux's swift	*Chaetura vauxi*
White-throated swift	*Aeronautes saxatalis*
Black-chinned hummingbird	*Archilochus alexandri*
Anna's hummingbird	*Calypte anna*
Rufous hummingbird	*Selasphorus rufus*
Allen's hummingbird	*Selasphorus sasin*
Calliope hummingbird	*Stellula calliope*
Belted kingfisher	*Megaceryle alcyon*
Common flicker	*Colaptes auratus*
Acorn woodpecker	*Melanerpes formicivorus*
Lewis woodpecker	*Asyndemus lewis*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Hairy woodpecker	*Dendrocopos villosus*
Downy woodpecker	*Dendrocopus pubescens*
Nuttall's woodpecker	*Dendrocopus nuttalli*
Western kingbird	*Tyrannus verticalis*
Ash-throated flycatcher	*Myiarchus cinerascens*
Black phoebe	*Sayornis nigricans*
Say's phoebe	*Sayornis saya*
Willow flycatcher	*Empidonax traillii*
Western flycatcher	*Empidonax difficilis*
Western wood pewee	*Contopus sordidulus*
Olive-sided flycatcher	*Nuttallornis borealis*
Vermilion flycatcher	*Pyrocephalus rubinus*
Horned lark	*Eremophila alpestris*
Violet-green swallow	*Tachycineta thalassina*
Tree swallow	*Iridoprocne bicolor*
Bank swallow	*Riparia riparia*
Rough-winged swallow	*Stelgidopteryx ruficollis*

COMMON NAME	SCIENTIFIC NAME
Barn swallow	*Hirundo rustica*
Cliff swallow	*Petrochelidon pyrrhonota*
Purple martin	*Progne subis*
Steller's jay	*Cyanocitta stelleri*
Scrub jay	*Aphelocoma coerulescens*
Yellow-billed magpie	*Pica nuttalli*
Common raven	*Corvus corax*
Common crow	*Corvus brachyrhynchos*
Black-capped chickadee	*Parus atricapillus*
Mountain chickadee	*Parus gambeli*
Plain titmouse	*Parus inornatus*
Bushtit	*Psaltriparus minimus*
Water pipit	*Anthus spinoletta*
Cedar waxwing	*Bombycilla cedrorum*
Phainopepla	*Phainopeple nitens*
Loggerhead shrike	*Lanius ludovicianus*
Starling	*Sturnus vulgaris*
Hutton's vireo	*Vireo huttoni*
Solitary vireo	*Vireo solitarius*
Orange-crowned warbler	*Vermivora celata*
Nashville warbler	*Vermivora ruficapilla*
Yellow warbler	*Dendroica petechia*
Yellow-rumped warbler	*Dendroica coronata*
Black-throated gray warbler	*Dendroica nigriscens*
Townsend's warbler	*Dendroica townsendi*
Black-throated blue warbler	*Dendroica caerulescens*
Black-throated green warbler	*Denroica virens*
Hermit warbler	*Dendroica occidentalis*
MacGillivray's warbler	*Oporonis tolmiei*
Common yellowthroat	*Geothlypis trichas*
Yellow-breasted chat	*Icteria virens*
Wilson's warbler	*Wilsonia pusilla*
House sparrow	*Passer domesticus*
Western meadowlark	*Sturnella neglecta*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Red-winged blackbird	*Agelaius phoeniceus*
Tri-colored blackbird	*Agelaius tricolor*
Hooded oriole	*Icterus cucullatus*
Brewer's blackbird	*Euphagus cyanocephalus*
Brown-headed cowbird	*Molothrus ater*
Western tanager	*Piranga lucoviciana*
Black-headed grosbeak	*Pheucticus melanocephalus*
Blue grosbeak	*Guiraca caerulea*
Lazuli bunting	*Passerina amoena*
Purple finch	*Carpodacus purpureus*
House finch	*Carpodacus mexicanus*

APPENDIX B (cont.)

COMMON NAME	SCIENTIFIC NAME
Pine siskin	*Carduelis pinus*
American goldfinch	*Carduelis tristis*
Lesser goldfinch	*Carduelis psaltria*
Lawrence's goldfinch	*Carduelis lawrencei*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Brown towhee	*Pipilo fuscus*
Savannah sparrow	*Passerculus sandwichensis*
Vesper sparrow	*Pooecetes gramineus*
Lark sparrow	*Chondestes grammacus*
Rufous-crowned sparrow	*Aimophila ruficeps*
Sage sparrow	*Amphispiza belli*
Dark-eyed junco	*Junco hyemalis*
Chipping sparrow	*Spizella passerina*
White-crowned sparrow	*Zonotrichia leucophrys*
Golden-crowned sparrow	*Zonotrichia atricapilla*
White-throated sparrow	*Zonotrichia albicollis*
Fox sparrow	*Passerella iliaca*
Lincoln's sparrow	*Melospiza lincolnii*
Song sparrow	*Melospiza melodia*

APPENDIX C

FISH SPECIES

APPENDIX C

Fish species found in the Sacramento River system (Source: Moyle 1976).

Anadromous Fishes

COMMON NAME	SCIENTIFIC NAME
Pacific lamprey	*Lampetra tridentata*
River lamprey	*Lampetra ayresi*
White sturgeon	*Acipenser transmontanus*
Green sturgeon	*Acipenser medirostris*
American shad	*Alosa sapidissima*
Pink salmon	*Oncorhynchus gorbuscha*
Chum salmon	*Oncorhynchus keta*
Silver salmon	*Oncorhynchus kisutch*
King salmon	*Oncorhynchus tschawytscha*
Sockeye salmon	*Oncorhynchus nerka*
Steelhead trout	*Oncorhynchus mykiss*
Striped bass	*Morone saxatilis*

Resident Fishes

COMMON NAME	SCIENTIFIC NAME
Brook lamprey	*Lampetra pacifica*
Threadfin shad	*Dorosoma petenense*
Kokanee	*Oncorhynchus nerka*
Brook trout	*Salvelinus fontinalis*
Dolly varden trout	*Salvelinus* sp.
Brown trout	*Salmo trutta*
Redband trout	*Salmo* sp.
Golden trout	*Salmo aquabonita*
Rainbow trout	*Oncorhynchus mykiss*
Arctic grayling	*Thymallus arcticus*
Carp	*Cyprinus carpio*
Goldfish	*Carassius auratus*
Golden shiner	*Notemigonus crysoleucas*
Sacramento blackfish	*Orthodon microlepidotus*
Hardhead	*Mylopharodon conocephalus*
Hitch	*Lavinia exicauda*
Sacramento squawfish	*Ptychocheilus grandis*
Tui chub	*Gila bicolor*
Thicktail chub	*Gila crassicauda*
Sacramento splittail	*Pogonichthys macrolepidotus*
California roach	*Hesperoleucus symmetricus*
Speckled dace	*Rhinichthys osculus*

COMMON NAME	SCIENTIFIC NAME
Lahontan redside	*Richardsonius egregius*
Fathead minnow	*Pimephales promelas*
Mountain sucker	*Catostomus platyrhynchus*
Sacramento sucker	*Catostomus occidentalis*
Channel catfish	*Ictalurus punctatus*
White catfish	*Ictalurus catus*
Yellow bullhead	*Ictalurus natalis*
Brown bullhead	*Ictalurus nebulosus*
Black bullhead	*Ictalurus melas*
Mosquitofish	*Gambusia affinis*
Threespine stickleback	*Gasterosteus aculeatus*
Sacramento perch	*Archoplites interruptus*
Black crappie	*Pomoxis nigromaculatus*
White crappie	*Pomoxis annularis*
Warmouth	*Lepomis gulosus*
Green sunfish	*Lepomis cyanellus*
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lepomis gibbosus*
Redear sunfish	*Lepomis microlophus*
Largemouth bass	*Micropterus salmoides*
Spotted bass	*Micropterus punctatus*
Smallmouth bass	*Micropterus dolomieui*
Redeye bass	*Micropterus coosae*
Yellow perch	*Perca flavescens*
Bigscale logperch	*Percina macrolepida*
Rough sculpin	*Cottus asperrimus*
Coastrange sculpin	*Cottus aleuticus*
Prickly sculpin	*Cottus asper*
Pit sculpin	*Cottus pitensis*
Marbled sculpin	*Cottus klamathensis*
Riffle sculpin	*Cottus gulosus*

APPENDIX D

SECTION 7 SPECIES LIST

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

March 17, 1994

Environmental Resources Branch

Mr. Wayne White, Field Supervisor
U.S. Fish and Wildlife Service
2800 Cottage Way
Sacramento, California 95825-1946

Dear Mr. White:

On December 14, 1990, your office provided us with a list of endangered, threatened, and candidate species that could occur in the area of the Sacramento River Flood Control Systems Evaluation, Phases II-V. Currently, we are preparing an Environmental Assessment and Biological Data Report for Phase III of this study.

Accordingly, updated information is requested on whether any listed, proposed, or candidate species occur in the Phase III study area. A map of the area is enclosed. We would appreciate a reply within 15 working days.

If you have any questions, please contact Mr. Mark Pelz of this office at (916) 557-6742.

Sincerely,

fy Walter Yep
Chief, Planning Division

Enclosure

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Sacramento Field Office
2800 Cottage Way, Room E-1803
Sacramento, California 95825-1846

In Reply Refer To:
1-1-94-SP-766

April 12, 1994

Mr. Walter Yep
Chief, Planning Division
Corps of Engineers-Sacramento
1325 J Street
Sacramento, California 95814-2922

Subject: Species List for Proposed Sacramento River Flood Control Systems Evaluation, Phase III, California

Dear Mr. Yep:

As requested by letter from your agency dated March 17, 1994, you will find enclosed a list of the proposed and listed endangered and threatened species that may be present in the subject project area (see Enclosure A). This list fulfills the requirement of the Fish and Wildlife Service to provide a species list pursuant to Section 7(c) of the Endangered Species Act, as amended, (ACT).

Some pertinent information concerning the distribution, life history, habitat requirements, and published references for the listed species is also attached. This information may be helpful in preparing the biological assessment for this project, if one is required. Please see Enclosure B for a discussion of the responsibilities Federal agencies have under Section 7(c) of the Act and the conditions under which a biological assessment must be prepared by the lead Federal agency or its designated non-Federal representative.

Formal consultation, pursuant to 50 CFR § 402.14, should be initiated if you determine that a listed species may be affected by the proposed project. If you determine that a proposed species may be adversely affected, you should consider requesting a conference with our office pursuant to 50 CFR § 402.10. Informal consultation may be utilized prior to a written request for formal consultation to exchange information and resolve conflicts with respect to a listed species. If a biological assessment is required, and it is not initiated within 90 days of your receipt of this letter, you should informally verify the accuracy of this list with our office.

Also, for your consideration, we have included a list of the candidate species that may be present in the project area (see Enclosure A). These species are currently being reviewed by our service and are under consideration for possible listing as endangered or threatened. Candidate species have no protection under the Endangered Species Act, but are included for your

consideration as it is possible that one or more of these candidates could be proposed and listed before the subject project is completed. Should the biological assessment reveal that candidate species may be adversely affected, you may wish to contact our office for technical assistance. One of the potential benefits from such technical assistance is that by exploring alternatives early in the planning process, it may be possible to avoid conflicts that could otherwise develop, should a candidate species become listed before the project is completed.

We appreciate your concern for endangered species. If you have further questions, please call Laurie Stuart Simons of this office at (916) 978-5408 extension 330. For questions concerning the endangered winter-run chinook salmon, please contact Jim Lecky, Endangered Species Coordinator, at the National Marine Fisheries Service, Southwest Region, 501 West Ocean Boulevard, Suite 4200, Long Beach California 90802-4213, or call him at (310) 980-4015.

Sincerely,

Cary C. Gould

for Dale A. Pierce
Acting Field Supervisor

Enclosures

cc: NMFS (Attn: Jim Lecky), Long Beach, CA
FWS-SFO (Corps Projects), Sacramento, CA

ENCLOSURE A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CANDIDATE SPECIES THAT MAY OCCUR IN THE AREA OF THE PROPOSED SACRAMENTO RIVER FLOOD CONTROL SYSTEMS EVALUATION, PHASE III, CALIFORNIA (1-1-94-SP-766, APRIL 12, 1994)

Listed Species

Fish

- winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)
- delta smelt, *Hypomesus transpacificus* (T)

Reptiles

- giant garter snake, *Thamnophis gigas* (T)

Birds

- bald eagle, *Haliaeetus leucocephalus* (T)
- American peregrine falcon, *Falco peregrinus anatum* (E)
- Aleutian Canada goose, *Branta canadensis leucopareia* (T)

Invertebrates

- valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Plants

- palmate-bracted bird's-beak, *Cordylanthus palmatus* (E)
- Solano grass, *Tuctoria mucronata* (E)

Proposed Species

Fish

- Sacramento splittail, *Pogonichthys macrolepidotus* (PT)

Invertebrates

- vernal pool fairy shrimp, *Branchinecta lynchi* (PE)
- vernal pool tadpole shrimp, *Lepidurus packardi* (PE)
- California linderiella, *Linderiella occidentalis* (PE)

Plants

- Colusa grass, *Neostapfia colusana* (PT)
- slender Orcutt grass, *Orcuttia tenuis* (PT)
- Hartweg's golden sunburst, *Pseudobahia bahiifolia* (PE)

Candidate Species

Fish

- green sturgeon, *Acipenser medirostris* (2R)
- longfin smelt, *Spirinchus thaleichthys* (2)

Amphibians

California tiger salamander, *Ambystoma californiense* (2▪)
western spadefoot toad, *Scaphiopus hammondi hammondi* (2R)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (2)

Birds

ferruginous hawk, *Buteo regalis* (2)
white-faced ibis, *Plegadis chihi* (2)
loggerhead shrike, *Lanius ludovicianus* (2)

Mammals

Pacific western big-eared bat, *Plecotus townsendii townsendii* (2)
greater western mastiff-bat, *Eumops perotis californicus* (2)
spotted bat, *Euderma maculatum* (2)

Invertebrates

Sacramento Valley tiger beetle, (*Cicindela hirticollis abrupta*) (2R)

Plants

Suisun aster, *Aster chilensis* var. *lentus* (2)
hispid bird's-beak, *Cordylanthus mollis* ssp. *hispidus* (2)
recurved larkspur, *Delphinium recurvatum* (2)
fragrant fritillary, *Fritillaria liliacea* (2)
adobe lily, *Fritillaria pluriflora* (2)
Contra Costa goldfields, *Lasthenia conjugens* (1)
delta tule-pea, *Lathyrus jepsonii* ssp. *jepsonii* (2)
legenere, *Legenere limosa* (2)
Mason's lilaeopsis, *Lilaeopsis masonii* (2)
veiny monardella, *Monardella douglasii* var. *venosa* (2)
valley sagittaria, *Sagittaria sanfordii* (2)
Mission Delores campion, *Silene verecunda* ssp. *verecunda* (2)
showy Indian clover, *Trifolium amoenum* (2*)

(E)--Endangered (T)--Threatened (P)--Proposed (CH)--Critical Habitat
(1)--Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)--Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.
(1R)-Recommended for Category 1 status.
(2R)-Recommended for Category 2 status.
(▪)--Listing petitioned.
(*)--Possibly extinct.

ENCLOSURE B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER
SECTIONS 7(a) and (c OF THE ENDANGERED SPECIES ACT

SECTION 7(a) Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species; 2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and 3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7(c) Biological Assessment--Major Construction Activity[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action[2] on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may proceed; however, no construction may begin.

We recommend the following for inclusion in the BA: an on-site inspection of the area affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat are present; a review of literature and scientific data to determine species' distribution, habitat needs, and other biological requirements; interviews with experts, including those within FWS, State conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of indirect effects of the proposal on the species and its habitat; an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to our office.

---

[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

[2] "Effects of the action" refers to the direct and indirect effects on an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

APPENDIX E

STATE LISTED THREATENED AND ENDANGERED SPECIES

APPENDIX E

List of state-listed threatened and endangered species[1].

Reptiles

giant garter snake, *Thamnophis gigas* (T)

Birds

Swainson's hawk, *Buteo swainsoni* (T)
willow flycatcher, *Empidonax traillii* (E)
bank swallow, *Riparia riparia* (T)
western yellow-billed cuckoo, *Coccyzus americus occidentalis* (E)

Plants

palmate-bracted bird's beak, *Cordylanthus palmatus* (E)

[1]List obtained using RareFind data base (CDFG, Natural Diversity Data Base)

(E)--Endangered
(T)--Threatened

APPENDIX F

HEP REPORT

APPENDIX F

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

REVISED DRAFT

HABITAT EVALUATION PROCEDURES STUDY

FOR THE

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION PHASE III

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS

SACRAMENTO, CALIFORNIA

FEBRUARY 1995

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

INTRODUCTION

These applications of the Fish and Wildlife Service'e (Service) Habitat Evaluation Procedures (HEP) are intended to quantify the impacts to fish and wildlife resources that would occur with the construction of the proposed levee improvements for the Sacramento River Flood Control System Evaluation Phase III Project. The proposed project is fully described in the "Project Description" section of the accompanying Fish and Wildlife Coordination Act (FWCA) Report.

The Service's HEP is used to quantify anticipated impacts to fish and wildlife and their habitats, and to determine mitigation needs. This particular HEP study addresses the direct effects of levee improvements to riparian woodland, emergent marsh, permanent wetland, and scrub-shrub cover-types.

STUDY AREA

The study area for this HEP includes all land and vegetation within the 20 proposed construction sites and three borrow areas. The study area is fully described within the accompanying FWCA report.

HEP DESCRIPTION

HEP is an impact assessment methodology developed by the Service which can be used to document the quality and quantity of available habitat for selected wildlife species. HEP provides information for two general types of wildlife habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same areas at future points in time. By combining the two types of comparisons, the impacts of proposed or anticipated land- and water-use changes on wildlife habitat can be quantified. In a similar manner, any compensation needs (in terms of acreage) for the project can also be quantified.

A HEP application is based on the assumption that habitat for selected wildlife species or communities can be described by a model which produces a Habitat Suitability Index (HSI). The HSI, a value from 0.0 to 1.0, is assumed to relate directly to the carrying capacity of the habitat being evaluated. The HSI is multiplied by the area of available habitat to obtain Habitat Units (HUs). Changes in habitat value and quantity are tracked over time at specified time periods known as target years (TYs). Those changes over the life of the project are annualized to yield Average Annual Habitat Units (AAHUs). The life of the project is based upon a 50-year period. The period of analysis is equal to the life of the project plus any construction period (2 years for this project). The difference in AAHUs for various project scenarios permit comparison of alternatives.

Impacts associated with each future scenario were evaluated for a number of target years. Table 1 lists the project's habitat changes for the target years chosen for each of the four future scenarios. To predict changes in a HSI for each future scenario, it was necessary to make assumptions regarding baseline and future values within project impact and compensation areas. These assumptions are listed in Apppendix F-1. Given these assumptions, long-term losses and gains in HUs can be estimated for each future scenario over the life of the project, then expressed as AAHU gains or losses.

The reliability of a HEP application, including the significance of HUs and AAHUs, is directly dependent on the ability of the HEP user(s) to assign a well-defined and accurate HSI to the selected evaluation species or communities. SIs and HSIs calculated from baseline and future assumptions are given in Appendix F-2. Also, the HEP user(s) must be able to identify and measure (or predict) the area of each distinct cover-type that is utilized by fish and wildlife within the project impact area. Both the HSIs and the cover-type acreages must also be reasonably estimable at various future points in time.

A fundamental and critical step in designing any HEP application is the setting of overall goals and objectives. In this HEP application, such goals and objectives were developed based on the overall, long-term resource management goals of the Service. The mitigation policies of the Service (see description within the body of the FWCA Report) were also carefully considered.

Table 1. Predicted habitat changes for future scenario target years.	
TARGET YEAR	ACTIONS
	FUTURE CONDITIONS WITHOUT THE PROJECT (IMPACT AREA, PA1)
Target Year 0	Baseline habitat conditions.
Target Years 1, 2, 52	Over time, riparian woodland values vary (depending on sites and species model variables); scrub-shrub values increase; permanent wetland values decrease; and emergent marsh values remain the same (the emergent marsh cover-type is within a managed system).
	FUTURE CONDITIONS WITH THE PROJECT (IMPACT AREA, PA2)
Target Year 0	Baseline habitat conditions.
Target Year 1	Project construction begins; riparian woodland, scrub-shrub, emergent marsh, and grassland/agriculture are removed, and permanent wetland is impacted.
Target Year 2	Construction at individual sites is completed. Disturbed areas are reseeded with native grass species; no woody vegetation.
Target Year 3	Values return to baseline conditions since the ditches are relocated during construction (emergent marsh cover-type)
Target Year 20	Impacted areas remain grassland with no woody vegetation (for all sites except emergent marsh). Values of other cover-types have decreased to 0.0.
Target Year 52	Same as Target Year 25
	FUTURE CONDITIONS WITHOUT MANAGEMENT (COMPENSATION AREA, MP1)
Target Year 0	Baseline habitat conditions, characterized by previously farmed lands.
Target Year 1	Baseline habitat conditions continue. Little change in existing vegetation.
Target Year 10	Same as Target Year 1.
Target Year 20	Same as Target Year 10.
Target Year 52	Same as Target Year 25.
	FUTURE CONDITIONS WITH MANAGEMENT (COMPENSATION AREA, MP2)
Target Year 0	Baseline habitat conditions characterized by previously farmed lands within the floodplain.
Target Year 1	Sites contoured as required for riparian woodland, scrub/shrub, and permanent wetland cover-type creation. Tree, shrub, and permanent wetland species planted.
Target Year 10	Permanent wetland values approaching full value as a cover-type. Woody vegetation plantings continue to mature.
Target Year 20	No change in permanent wetland values. Scrub/shrub values and forested areas continue to develop.
Target Year 52	Emergent wetland similar to Target Year 25. Scrub/shrub values and forested areas reach maximum values.

The following goals and objectives were established for the HEP used in this study:

1. The primary goal was to evaluate, as required by the FWCA, the impacts on fish and wildlife from the proposed remedial levee repair work.

2. Quantify habitat conditions before project construction.

3. Quantify habitat conditions after project construction.

4. Develop and evaluate an array of management alternatives designed to compensate impacts from the project.

5. Determine the replacement acreage of various habitats necessary to compensate for the impacts of the project on the terrestrial cover-types

in the project area. More specifically, the goal of the HEP analysis is to provide compensation recommendations that would result in *no net loss of in-kind habitat values* for riparian woodland, scrub/shrub, emergent marsh, and permanent wetland. This is in accordance with the Service's classification of these habitats as Resource Category 2 under the Service's Mitigation Policy (Federal Register 46:15, January 23, 1981). In-kind replacement, as defined in the Mitigation Policy, means providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate those lost (Table 2).

Table 2. Evaluation species, Resource Categories, and mitigation planning goals for the cover-types found within the Sacramento River Flood Control System Evaluation, Phase III project area.

COVER-TYPE	EVALUATION SPECIES	RESOURCE CATEGORY	MITIGATION GOAL
Riparian woodland	Nesting raptors	2	No net loss of in-kind habitat value
Scrub-shrub	Migratory songbirds	2	No net loss of in-kind habitat value
Emergent marsh	Great egret	2	No net loss of in-kind habitat value
Permanent wetland	Waterfowl	2	No net loss of in-kind habitat value
Grassland/Agricultural	Small mammals	3	No loss of habitat value while minimizing loss of in-kind habitat value

The goal of the HEP analysis is to also provide compensation recommendations that would result in *no net loss of habitat value while minimizing the loss of in-kind habitat value* for annual grasslands. This is in accordance with the Service's classification of these habitats as Resource Category 3 under the Service's Mitigation Policy. Resource Category 3 habitat is of high to medium value for the evaluation species and is relatively abundant on a national basis. If losses are likely to occur, then the Service will recommend that these losses be compensated by replacement of habitat value so that the total loss of habitat value will be eliminated (Table 2).

METHODOLOGY

Participants in the HEP data collection field work included representatives from the Service (Caroline Wilkinson), Corps of Engineers (Mark Pelz, Tom Bonetti, and Tom Lasala), and Reclamation Board (Duane Cornett). Staff from the Department of Fish and Game was invited to participate, but was unable to attend.

The four cover-types identified for evaluation of baseline conditions are: 1) riparian woodland; 2) scrub/shrub; 3) emergent marsh; 4) permanent wetland; and 5) grassland/agriculture. Compensation of all but the grassland/ agriculture cover-type would require in-kind replacement of value and acreage, based on the Service's Mitigation Policy guidance and Resource Category determinations (See FWCA report). Prior to field sampling, the HEP team agreed to forego impact assessment of the grassland/agriculture cover-type because loss of habitat values could be mitigated on-site after construction through reseeding. Also, it was determined that the project would not impact riverine fisheries due to site locations. Table 1 of the FWCA report shows site locations, proposed remedial repair work alternatives, miles impacted, and acres impacted for each of the 30 impact areas.

Four models were used in the HEP application. Individual species models were used for each cover-type that would be impacted (Appendix F-3). These are the: 1) yellow warbler and northern oriole for riparian woodland; 2) yellow warbler for scrub/shrub; 3) great egret for emergent marsh; and 4) mallard for permanent wetland. Table 3 presents the evaluation species, variable descriptions, cover-types measured, and methods used to measure each variable.

The capacity of each sample site to meet the needs of the cover-type within the project impact and compensation areas was determined by the HEP team through measurement of specific habitat variables. A HSI was then manually calculated for each cover-type, yielding a rating on a scale of 0.0 to 1.0, with higher numerical ratings indicative of a higher value cover-type.

Table 3. Evaluation species, variable description, cover-type per variable, and methods used to obtain the variables found in each HSI species model.

EVALUATION SPECIES	VARIABLE DESCRIPTION	COVER-TYPE	METHOD USED
Great egret	V1 - Percent of study area with water 4.0-9.0 in deep. V2 - Percent of substrate in zone 4.0-9.0 in deep covered by submerged or emergent vegetation.	Emergent marsh	•Graduated rod with belt transect •Belt transect
Northern oriole	V1 - Average height of deciduous tree canopy. V2 - Percent deciduous tree crown cover. V3 - Stand width.	Riparian woodland	•Graduated rod along line intercept •Line intercept •Visual estimation in field
Yellow warbler	V1 - Percent of deciduous shrub crown cover. V2 - Average height of deciduous shrub canopy. V3 - Percent of deciduous shrub canopy comprised of hydrophytic shrubs.	Riparine woodland and scrub/shrub	•Line intercept •Graduated rod along line intercept •Line intercept
Mallard	Breeding criteria: V1 - The abundance and availability of suitable food type within 0.6 mi of sample site V2 - The presence of fresh drinking water for mallard broods (or the degree of salinity) on, adjacent to, or near the sample site. V3 - Suitable nest sites. Wintering criteria: V1 - The abundance and availability of marsh and aquatic vegetation within 1.0 *mi from* the *sample* site and/or the abundance of described agricultural fields within 25 mi from the sample site. V2 - The presence of open bodies of water and the density of interspersion of emergent vegetation.	Permanent wetland	•Visual estimation in field •Visual estimation in field •Visual estimation in field •Visual estimation in the field •Visual estimation in the field

RESULTS AND DISCUSSION

EVALUATION OF LOSSES FROM THE PROPOSED PROJECT

Levee crown restoration, toe drain and berm construction, slurry wall construction, drainage ditch relocation and/or filling, lime treatment of levee material, seepage interceptor trench drain construction, seepage stability berm construction, and clearing for equipment access would adversely affect vegetation at all 30 worksites. A total of 224.28 acres would be disturbed. Vegetative cover-types that would be adversely impacted by the project would include 8.24 acres of riparian woodland; 3.22 acres of scrub-shrub; 13.08 acres of emergent marsh; 0.05 acres of permanent wetland; and 199.69 acres of grassland/agriculture. Impacts to grasses on the levee slopes and adjacent agricultural lands would be temporary; these areas would recover their habitat values within a short period after construction is completed (2 years). Also along the levees, a total of 61 individual trees and shrubs would be removed. Since these individual trees are widely scattered throughout the 18.27 miles of levees which would be repaired, they were enumerated by reach, but not included as a specific cover-type. No woody vegetation losses were identified at construction staging areas or borrow sites since impacts to woody vegetation at these sites could be avoided by fencing or flagging them prior to initiation of construction activities. Terrestrial habitat losses, in terms of Average Annual Habitat Units (AAHUs) and acres lost, are presented in Table 4. For acres impacted, we assumed a worst-case scenario in that the Corps would construct berms/toe drains rather than cutoff walls (least impact). No new cover types would be created by project work or associated mitigation measures.

About 224.28 total acres of existing cover types would be impacted by the project. Lands lost to levee enlargement would be subject to existing levee maintenance activities. A summary of losses is presented in Table 5.

Specific Worksites:

Site 1. The proposed construction of 0.70 mile of interceptor trench drain would impact about 0.09 acre of grassland/agriculture.

Site 2. The proposed construction of 1.00 mile of interceptor trench drain would impact about 0.12 acre of grassland/agriculture.

Site 2-1. The proposed construction of 0.05 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 2-2. The proposed construction of 0.05 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 2-3. The proposed construction of 0.05 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 2-4. The proposed construction of 0.03 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Table 4. Cover-types impacted, acres impacted, total AAHUs lost, and individual trees lost for the Sacramento River Flood Control System Evaluation, Phase III project.

SITE #	COVER-TYPE IMPACTED	ACRES IMPACTED	TOTAL AAHUs LOST[1]	INDIVIDUAL TREES LOST
1	Grassland/agriculture	0.09	--	0
2	Grassland/agriculture	0.12	--	0
2-1	Grassland/agriculture	0.01	--	0
2-2	Grassland/agriculture	0.01	--	0
2-3	Grassland/agriculture	0.01	--	0
2-4	Grassland/agriculture	0.01	--	0
2-5	Grassland/agriculture	0.01	--	0
2-6	Grassland/agriculture	0.01	--	0
2-7	Grassland/agriculture	0.01	--	0
2-8	Grassland/agriculture	0.01	--	0
2-9	Grassland/agriculture	0.01	--	0
2-10	Grassland/agriculture	0.01	--	0
3	Grassland/agriculture Emergent marsh	14.60 .05 14.65	-- 0	0
4	Grassland/agriculture	14.60	--	7
5	Emergent marsh Grassland/agriculture	0.73 4.41 5.14	0 --	9
6	Grassland/agriculture	12.67	--	0
7	Grassland/agriculture	10.19	--	0
9	Grassland/agriculture	1.93	--	0
10	Grassland/agriculture	1.38	--	33
11	Grassland/agriculture	5.51	--	7
12	Riparian woodland Emergent marsh Grassland/agriculture	5.69 7.39 30.74 43.82	4.69 0.18 -- 4.87	0
12A	Grassland/agriculture	10.33	--	0
13	Emergent marsh Grassland/agriculture	1.15 5.32 6.47	0.18 --	0
14	Grassland/agriculture	10.19	--	0
15A	Emergent marsh Grassland/agriculture	3.62 16.63 20.25	0.18 --	0
15B	Grassland/agriculture	51.24	--	0
17	Riparian woodland Permanent wetland Grassland/agriculture	0.68 0.05 1.84 2.57	0.56 0.01 -- 0.57	1
18	Riparian woodland Grassland/agriculture	1.87 0.70 2.57	1.56 --	3
19	Emergent marsh Grassland/agriculture	0.14 2.61 2.75	0 --	13
20	Scrub-shrub Grassland/agriculture	3.22 4.49 7.71	2.67 --	0
		TOTAL: 224.28	TOTAL: 10.03	TOTAL: 73

[1]No HEP was conducted on grassland/agricultural cover-types, as indicated by the two dashed lines (--).

Table 5. Summary of cover-types impacted, acres impacted, total AAHUs lost, and individual trees that would be lost from Sacramento River Flood Control System Evaluation, Phase III project.

COVER-TYPES IMPACTED (excludes borrow sites)	TOTAL ACRES IMPACTED	TOTAL AAHUs LOST	INDIVIDUAL TREES LOST
Grassland/agriculture	199.69	--	(from grasslands/ agriculture areas)
Emergent marsh	13.08	0.54	
Riparian woodland	8.24	6.81	
Scrub-shrub	3.22	2.67	
Permanent wetland	0.05	0.01	
	TOTAL: 224.28	TOTAL: 10.03	TOTAL: 73

Site 2-5. The proposed construction of 0.06 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 2-6. The proposed construction of 0.06 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 2-7. The proposed construction of 0.03 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 2-8. The proposed construction of 0.02 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 2-9. The proposed construction of 0.03 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 2-10. The proposed construction of 0.03 mile of interceptor trench drain would impact about 0.01 acre of grassland/agriculture.

Site 3. The proposed lime treatment and ditch relocation along 1.00 mile would impact about 0.05 acre of emergent marsh and about 14.60 acres of grassland/agriculture. Impacts to emergent marsh (assuming that the ditch is relocated to provide equivalent habitat value) would result in 0.0 AAHUs being lost, due to such low acreage impact.

Site 4. The proposed construction of 1.00 mile of a berm/drain would impact about 14.60 acres of grassland/agriculture.

Site 5. The proposed filling of a seasonal ditch and restoring the landside toe along 0.60 mile would impact about 0.73 acre of concrete-lined channel, and about 4.41 acres of grassland/agriculture. Impacts to the concrete-lined channel would result in the loss of 0.0 AAHUs, since no emergent marsh cover-type value exists at this site (Site 5 was evaluated as emergent-marsh cover-type even though it contains a concrete-lined channel).

Site 6. The proposed construction of 0.87 mile of a berm/drain would impact about 12.67 acres of grassland/agriculture.

Site 7. The proposed construction of 0.70 mile of a berm/drain would impact about 10.19 acres of grassland/agriculture.

Site 9. The proposed construction of 0.20 mile of a berm/drain would impact about 1.93 acres of grassland/agriculture.

Site 10. The proposed construction of 0.10 mile of a berm/drain would impact about 1.38 acres of grassland/agriculture.

Site 11. The proposed construction of 0.40 mile of a berm/drain would impact about 5.51 acres of grassland/agriculture.

Site 12. The proposed lime treatment, ditch relocation, and reshaping of the levee along 2.17 miles would impact about 5.69 acres of riparian woodland, about 7.39 acres of emergent marsh, and about 30.74 acres of grassland/ agriculture. Impacts to riparian woodland would result in a loss of 4.69 AAHUs, and impacts to emergent marsh would result in the loss of 0.18 AAHUs.

Site 12A. The proposed lime treatment along 0.85 mile would impact about 10.33 acres of grassland/agriculture.

Site 13. The proposed lime treatment and ditch relocation along 0.38 mile would impact about 1.15 acres of emergent marsh and 5.32 acres of grassland/ agriculture. Impacts to emergent marsh would result in the loss of 0.18 AAHUs.

Site 14. The proposed construction of 0.70 mile of a berm/drain would impact about 10.19 acres of grassland/agriculture.

Site 15A. The proposed levee crown restoration, lime treatment, and ditch relocation along 1.32 miles would impact about 3.62 acres of emergent marsh and 16.63 acres of grassland/agriculture. Impacts to emergent marsh (assuming ditch relocation design would provide equivalent values to those lost) would result in the loss of 0.18 AAHUs.

Site 15B. The proposed levee crown restoration and lime treatment along 4.82 miles would impact about 51.24 acres of grassland/agriculture.

Site 17. The proposed construction of 0.20 mile of a cutoff wall and/or berm stabilization would impact about 0.68 acre of riparian woodland, about 0.05 acres of permanent wetland, and about 1.84 acres of grassland/agriculture. Impacts to riparian woodland would result in the loss of 0.56 AAHUs, and impacts to permanent wetland would result in the loss of 0.01 AAHUs.

Site 18. The proposed construction of 0.15 mile of a cutoff wall or berm stabilization would impact about 1.87 acres of riparian woodland and about 0.70 acre of grassland/agriculture. Impacts to riparian woodland would result in the loss of 1.56 AAHUs.

Site 19. The proposed construction of 0.20 mile of a berm/drain and ditch filling would impact about 0.14 acres of emergent marsh and about 2.61 acres of grassland/agriculture. Impacts to emergent marsh would result in the loss of 0.0 AAHUs since no cover-type value exists at this site (dry ditch).

Site 20. The proposed construction of 0.50 mile of a berm/drain or berm stabilization would impact about 3.22 acres of scrub-shrub and about 4.49 acres of grassland/agriculture. Impacts to scrub-shrub would result in the loss of 2.67 AAHUs.

Appendix F-4 (Forms B, D, and H) gives the HEP analysis output values (HSIs, HUs, AAHUs, net changes in AAHUs, and area needed for compensation).

Non-woody vegetated cover types (grasslands) that would be disturbed by placement of toe drains or levee enlargement, are temporary impacts which can be mitigated by reseeding. Therefore, these lands are not included in this analysis.

Three borrow sites would be needed to provide necessary volume of embankment material for levee restoration and for the landside toe berms. Borrow Site 1 (20.0 acres) is composed of sandy soils and grasses. Borrow Site 2 (48 acres), is a reseeded area composed of various vegetative species including grasses, daisies (Compositae family), cottonwood seedlings, cockelbur (*Xanthium strumarium*), mint (Labiatae family), and wild mustard. Borrow Site 3 (40 acres) is composed of a fallow field (thistle) and scattered trees (i.e., cottonwoods).

MITIGATION

Three potential compensation sites were identified: **Mitigation Site 1** (60.0 acres) is located in the Sutter Bypass near the confluence of the Feather and Sacramento Rivers, (Figure 1) near the Sacramento Slough. It is composed of fallow fields containing weeds and is surrounded by riparian forest. Mitigation Site 1 is our preferred site due to its location, access, and management potential. **Mitigation Site 2**, (70.0 acres), is located in the Sutter Bypass (Figures 2 and 3), along the Sacramento River between River Mile 84.0 and the East Canal, just north of Gray's Bend. This site currently is farmed for safflower. **Mitigation Site 3**, (17.0 acres) is located in the Sutter Bypass south of the Sacramento Slough along the East Canal (Figure 4). It is located near Sacramento River Mile 83.0 and currently supports a jajoba crop. Figure 5 shows all three potential mitigation sites.

A single compensation scenario, using Mitigation Site 1, was evaluated to replace the riparian woodland, scrub-shrub, and permanent wetland cover-types that would be lost with the project. This scenario involves the acquisition, development, and management of a compensation area, preferably adjacent to the Sacramento or Feather Rivers. Since all of the sites currently have a HSI value of 0.0 for the HEP evaluation species (see HEP report Appendix F), any or a combination of sites could theoretically be used to compensate for unavoidable adverse impacts of the project. Habitat values and acreages lost, for each cover-type, would be replaced on the site(s) by preparing the sites, replanting, and ensuring the successful establishment of the desired cover-type vegetation.

<u>Riparian Woodland</u>. With the project, 5.69 acres of riparian woodland would be impacted at Site 12, 0.68 acres would be impacted at Site 17, and 1.87 acres

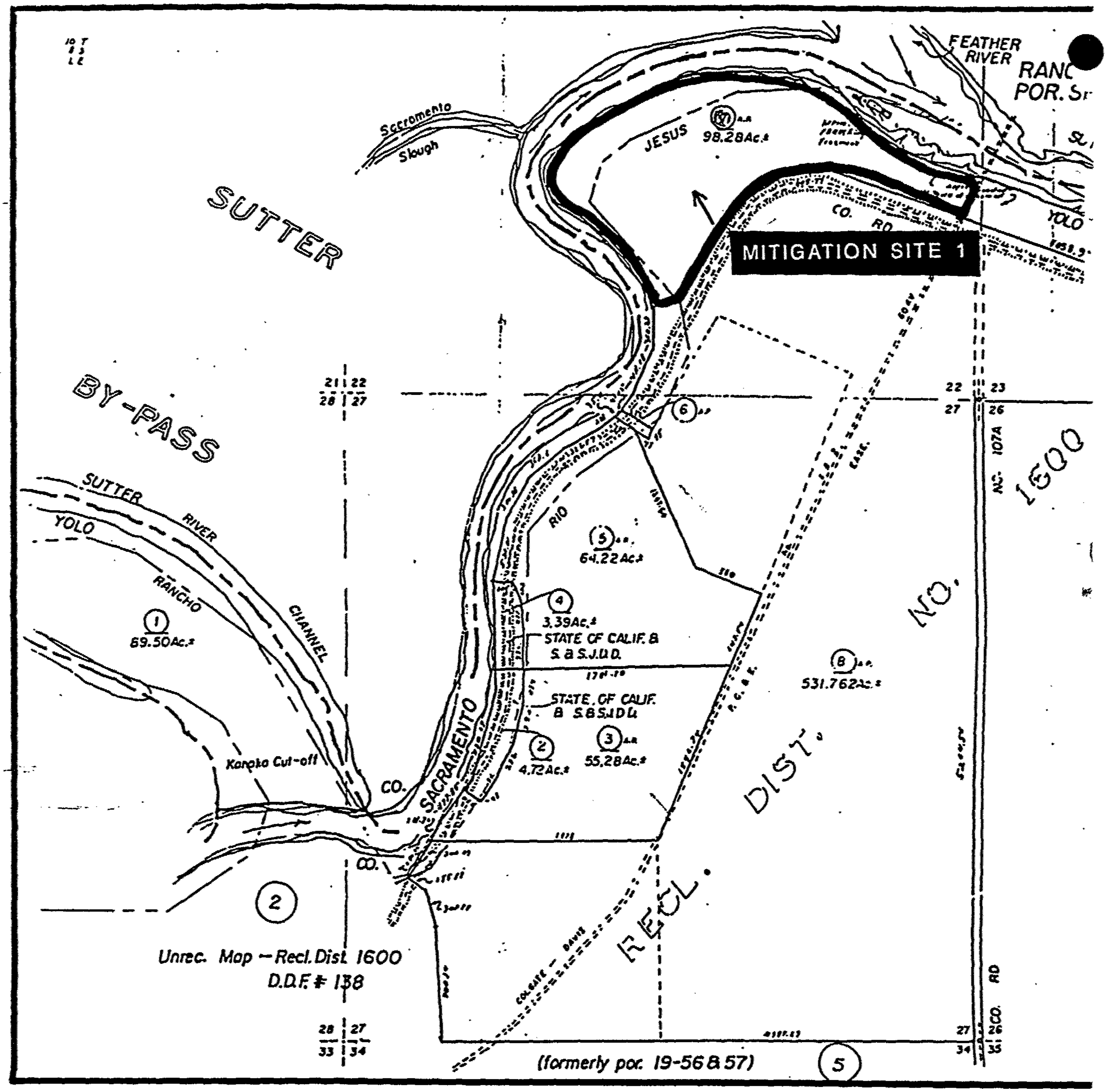


Figure 1. Mitigation Site 1 location for the Sacramento River Flood Control System Evaluation, Phase III project.

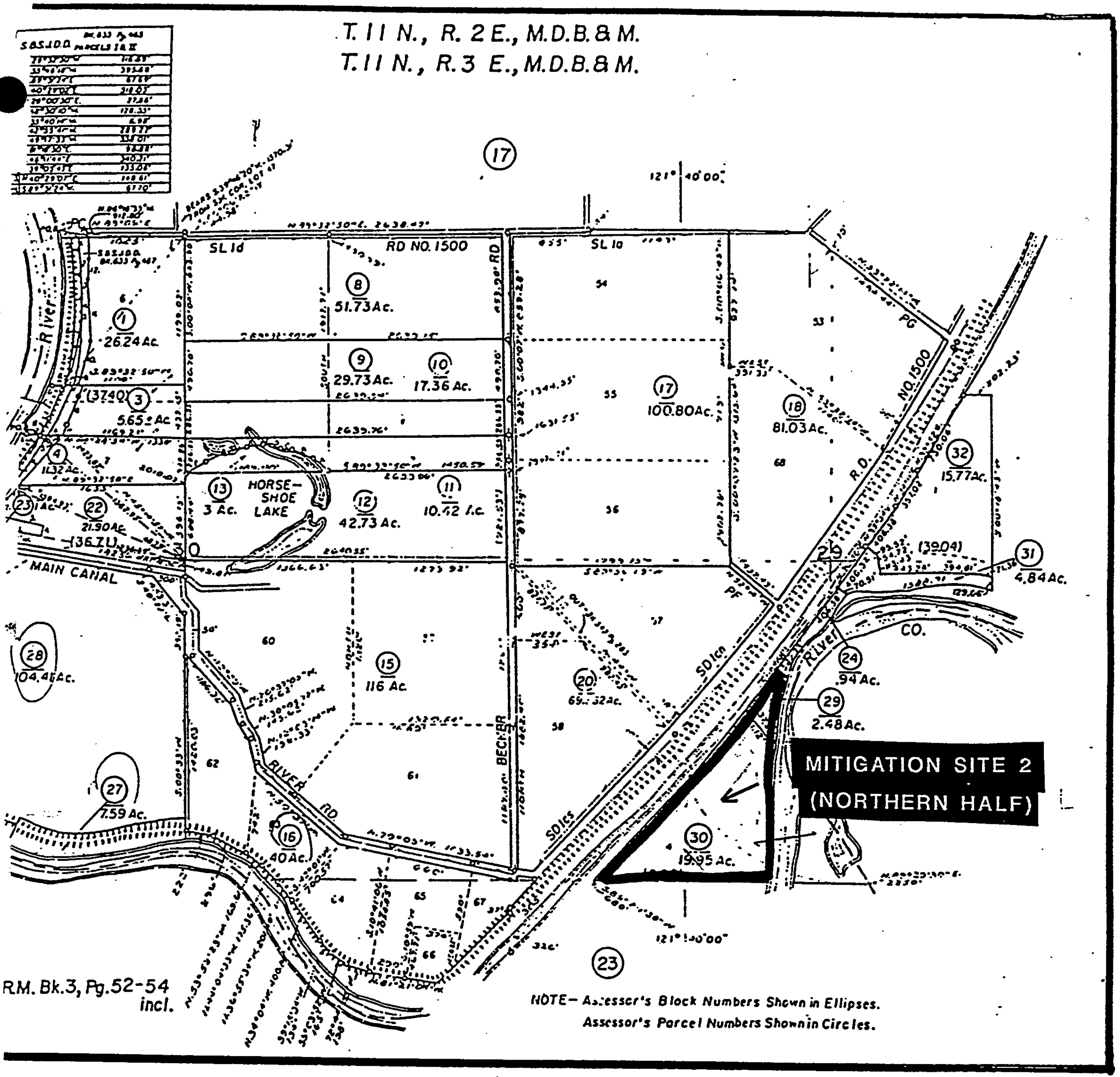


Figure 2. Mitigation Site 2 (northern half) location for the Sacramento River Flood Control System Evaluation, Phase III project.

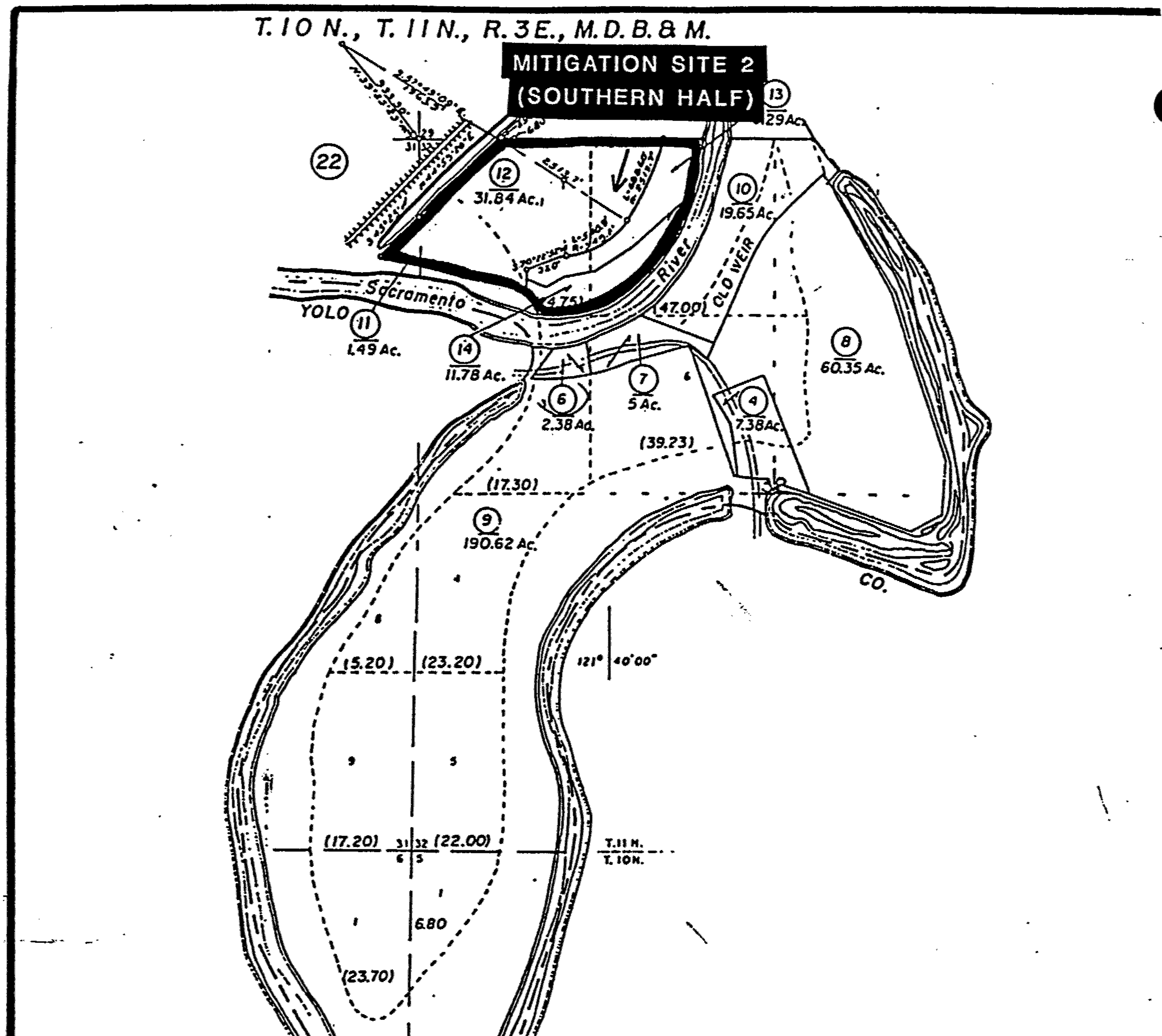


Figure 3. Mitigation Site 2 (southern half) location for the Sacramento River Flood Control System Evaluation, Phase III project.

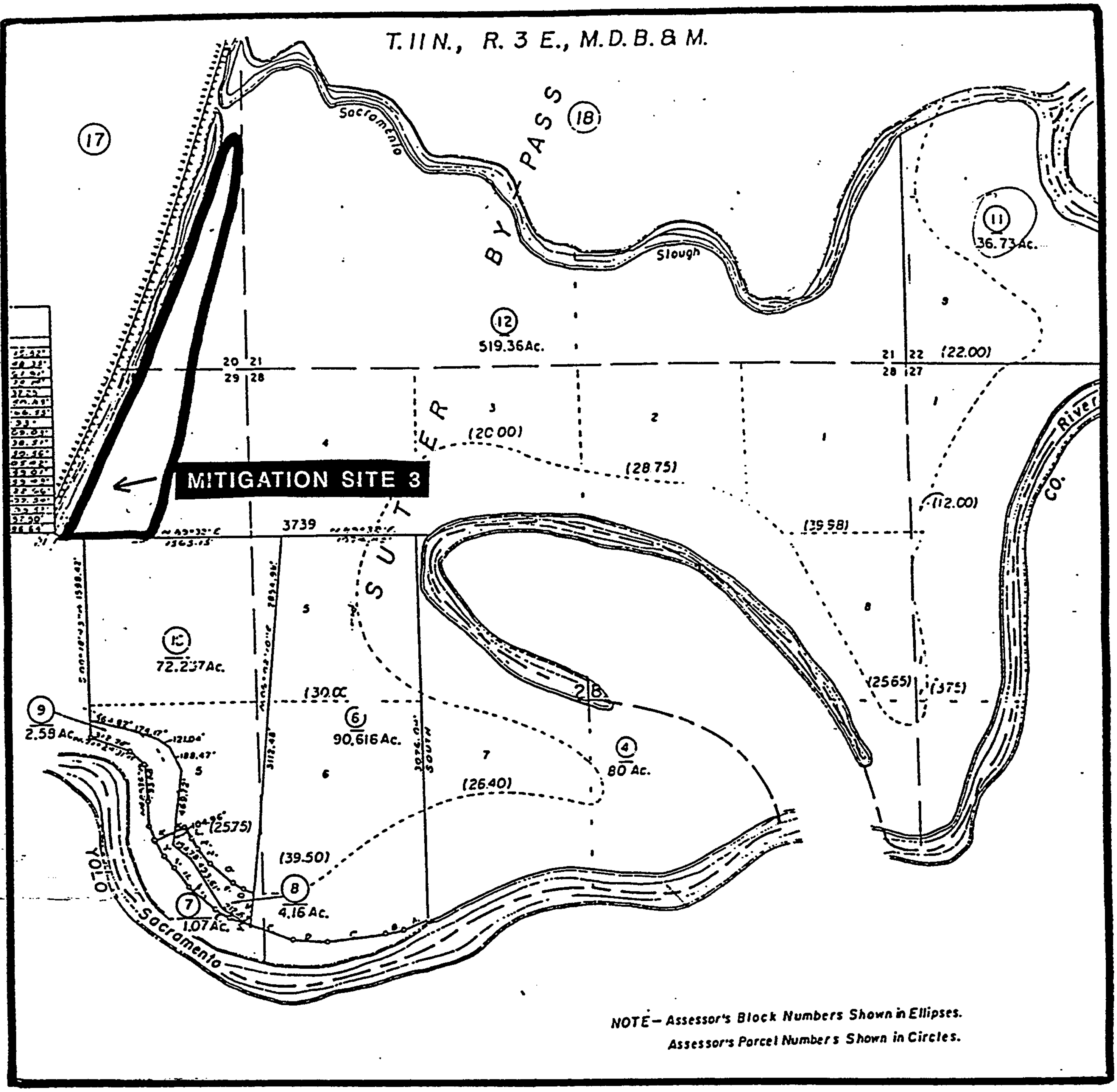


Figure 4. Mitigation Site 3 location for the Sacramento River Flood Control System Evaluation, Phase III project.

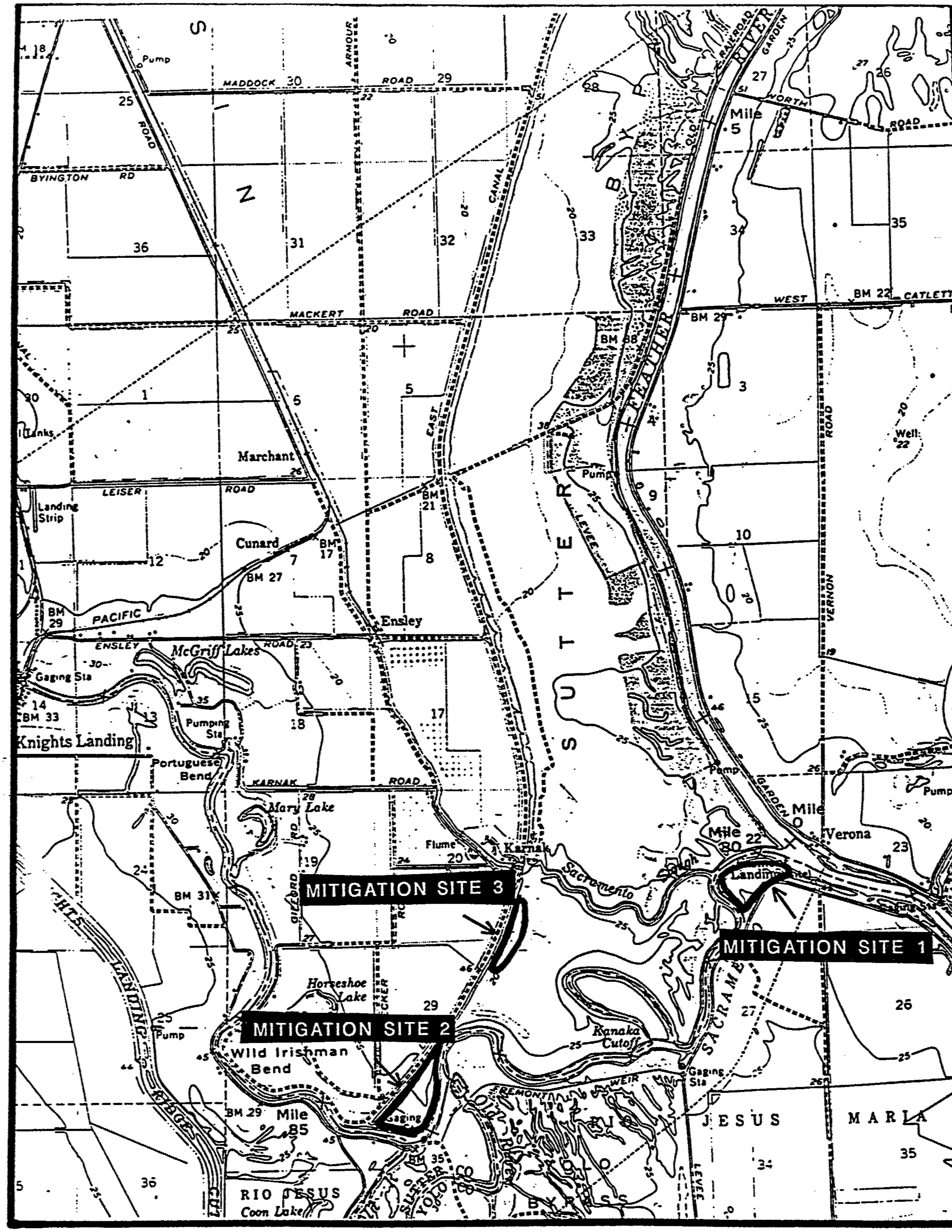


Figure 5. Mitigation Sites 1, 2, and 3 locations for the Sacramento River Flood Control System Evaluation, Phase III project.

would be impacted at Site 18, resulting in a total acreage of 8.24. HEP results (Table 6 and Appendix F) showed that the impacts would be fully compensated by replanting 11.74 acres of riparian vegetation at a suitable compensation site (Mitigation Site 1). Table 7 gives a summary of cover-types impacted. acres impacted, total AAHUs gained, acres needed for compensation and number of trees required to be planted for compensation.

Development of the site would involve the planting of various riparian tree species including Fremont cottonwoods, valley oaks, and willows. The species mix and density should be sufficient to establish 60 to 80 percent canopy cover by the end of the 52-year period of analysis. Plantings can be obtained from local stock through cuttings and seeds, and grown at a local commercial nursery. All plantings would require watering, weed control, protection from predation, and appropriate replacement of dead or dying plantings. Watering and maintenance should be required until the plants were self-sufficient and capable of self-regeneration. A 20-year monitoring period beyond the establishment period would be required to determine the long-term success of the plantings and the overall mitigation effort. Monitoring would be required on a fixed schedule, such as every year for the first 5 years of the 20-year period, and then every 5 years thereafter. If, within the monitoring period, revegetation efforts are determined to be unsuccessful in meeting criteria established for the site, corrective action should be required until the revegetation goal is met. Annual progress reports would be submitted by the local project sponsor to the Corps, Service, and Department of Fish and Game for each of the first 10 years of the monitoring period, and each fifth year thereafter.

Estimated costs to replace riparian vegetation were $25,000 per acre in 1993, excluding land acquisition and maintenance costs. Irrigation (drip system) would be required for a minimum of at least 6 years, or until the plantings are well established and self-sustaining. Any dead or decadent trees and shrubs would be replaced and maintained until well established.

<u>**Scrub-shrub**</u>. With the project, 3.22 acres of scrub-shrub habitat would be impacted at Site 20. HEP results show that project impacts would be fully compensated by establishing 4.59 acres of scrub-shrub habitat at Mitigation Site 1 (Table 6).

Development of the site would include the planting of various riparian scrub-shrub species including willows and box elders. The species would be planted at a density which would establish 60-80 percent canopy cover within 10 years. Costs have not yet been determined, but would be expected to be somewhat less than those stated for the riparian forest cover-type.

<u>**Emergent marsh**</u>. With the project, 0.05 acre would be impacted at Site 3; 12.16 acres would be impacted at Sites 12, 13 and 15A; and 0.87 acre would be impacted at Sites 5 and 19. The management plan would provide a net increase of 4.33 AAHUs for Site 3; 23.37 AAHUs for Sites 12, 13, and 15A; and 2.60 AAHUs for Sites 5 and 19. For Site 3, 0.05 acre would be needed for compensation; for Sites 12, 13, and 15A, 12.36 acres would be needed for compensation; and for Sites 5 and 19, 0.87 acres would be needed for

Table 6. Compensation needs for the proposed worksites for the Sacramento River Flood Control System Evaluation, Phase III project.

SITE #	COVER-TYPE IMPACTED	COMPENSATION ACREAGE	TOTAL AAHUs GAINED	NO. OF TREES TO PLANT
1	Grassland/agriculture	0	--	0
2	Grassland/agriculture	0	--	0
2-1	Grassland/agriculture	0	--	0
2-2	Grassland/agriculture	0	--	0
2-3	Grassland/agriculture	0	--	0
2-4	Grassland/agriculture	0	--	0
2-5	Grassland/agriculture	0	--	0
2-6	Grassland/agriculture	0	--	0
2-7	Grassland/agriculture	0	--	0
2-8	Grassland/agriculture	0	--	0
2-9	Grassland/agriculture	0	--	0
2-10	Grassland/agriculture	0	--	0
3	Emergent marsh Grassland/agriculture	0.05 0	4.33 --	0
4	Grassland/agriculture	0	--	35
5, 19	Emergent marsh Grassland/agriculture	0.87 0	2.60 --	45
6	Grassland/agriculture	0	--	0
7	Grassland/agriculture	0	--	0
9	Grassland/agriculture	0	--	0
10	Grassland/agriculture	0	--	165
11	Grassland/agriculture	0	--	35
12 12, 13, 15A 12	Riparian woodland Emergent marsh Grassland/agriculture	8.08 12.36 0 20.44	6.97 23.37 -- 30.34	0
12A	Grassland/agriculture	0	--	0
13	Grassland/agriculture	0	--	0
14	Grassland/agriculture	0	--	0
15A	Grassland/agriculture	0	--	0
15B	Grassland/agriculture	0	--	0
17	Riparian woodland Permanent wetland Grassland/agriculture	0.97 0.05 0 0.98	1.16 0.44 -- 1.60	5
18	Riparian woodland Grassland/agriculture	2.69 0	2.32 --	15
19	Grassland/agriculture	0	--	65
20	Scrub-scrub Grassland/agriculture	4.59 0	3.49 --	0
		TOTAL: 29.66	TOTAL: 44.68	TOTAL: 365

Table 7. Summary of cover-types impacted, acres impacted, total AAHUs gained, acres needed for compensation, and number of trees required to be planted for compensation for the Sacramento River Flood Control System Evaluation, Phase III project.

COVER-TYPE IMPACTED	TOTAL ACRES IMPACTED	TOTAL ACRES NEEDED FOR COMPENSATION	TOTAL AAHUs GAINED	NUMBER OF TREES TO PLANT
Grassland/agriculture	199.69	--	--	(from grassland/agricultural areas)
Emergent marsh	13.08	13.28	30.30	
Riparian woodland	8.24	11.74	10.45	
Scrub-shrub	3.22	4.59	3.49	
Permanent wetland	0.05	0.05	0.44	
TOTAL	224.28	29.66	44.68	365

compensation (Table 6). Although Site 5 was evaluated as emergent marsh cover-type, it contains a concrete line channel, and will be replaced at a ratio of 1:1. No AAHUs were lost at Site 5 or Site 19, which also contains no emergent marsh cover-type.

In accordance with the Service's mitigation policies in Region 1, there can be "no net loss of in-kind habitat value *or acreage*" (whichever is greater in acreage). For Site 3, the 0.05 acres required for full compensation could be replaced by relocating the ditch, and slightly expanding the acreage suitable for wetland vegetation establishments. The same could occur with Sites 5 and 19. For Sites 12, 13, and 15A, 12.36 acres required for full compensation could be replaced at a ratio of 1:1.

The Service recommends enhancement whenever possible. The relocated drainage ditches could be enhanced to provide better habitat values than are currently present at the sites. This could be achieved by 1) widening the ditches to increase the overall habitat area; 2) maintaining the ditches at a specific water level range (4.0 to 6.0 inches); 3) maintaining the substrate in the 4.0 to 9.0-inch-zone, to be covered by submerged or emergent vegetation (i.e., tules and cattails), at 30 to 60 percent; and

<u>Permanent wetland</u>. One-half acre of lacustrine wetland exists at Site 17. With the project, about 0.05 acre of this habitat could be impacted. The Corps may be able to avoid the area, however, at this time we have analyzed the impact for a worst case scenario. The impact, if it occurs, would take place along the edge of the permanent pond where it borders the toe of the existing levee. The management plan (see Appendix F), developed for the site, would provide a net increase of 0.44 AAHUs. The loss of 0.05 acres (worst case), however, is insignificant in terms of overall acreage, but may involve a "take" of the giant garter snake. Should the giant garter snake be determined to be present, or suitanble habitat be present, Section 7 consultation should be initiated.

<u>Grassland/agriculture</u>. Any loss of grassland habitat values due to project construction should be offset by seeding the disturbed areas and newly created berms with native grasses and forbs. Seeding should be conducted just prior to the rainy season. This would allow sufficient germination and establishment of these species. Estimated cost to reseed would be about $700/acre (per 1993 calculation).

__Individual trees and shrubs__. Any individual trees and shrubs within the grassland/agricultural areas removed along the landside toe of the levee and adjacent areas would require replacement. The trees provide important perching sites for raptors such as Swainson's and red-tailed haswks. They also provide cover for passerine birds, and valley oak and black walnut trees provide food for species such as the western gray squirrel. The shrubs provide cover for small mammals such as the black-tailed jackrabbit California vole. Because of their value to various wildlife species within the proposed project area, mature trees and shrubs should be replaced at a ratio of at least 5:1. All plantings would require watering and maintenance for a minimum of 6 years. The most efficient watering method is the drip system. The loss of 73 scattered individual trees would be mitigated by planting 365 trees. All plantings would require watering, weeding, and protection from predation. Tree species per site that could be impacted with the project are found in Table 8. Costs have not yet been determined.

Table 8. Tree species per site that may be removed by the Sacramento River Flood Control System Evaluation, Phase III project.

SITE #	NUMBER OF TREES	SPECIES OF TREES
4	7	3 valley oaks, 4 black walnuts
5	9	5 cottonwoods, 2 ashes, 2 black walnuts
10	33	2 box elders, 12 black walnuts, 10 English walnuts, 1 cottonwood, 1 Oregon ash, 6 willows, 1 valley oak
11	7	2 valley oaks, 4 black walnuts, 1 English walnut
17	1	1 valley oak
18	3	3 valley oaks
19	13	13 valley oaks
	73	

LITERATURE CITED

USACE (U.S. Army Corps of Engineers). 1991. Sacramento River Flood Control System Evaluation, Initial Appraisal Report, Mid-Valley Area. Sacramento, California.

USFWS (U.S. Fish and Wildlife Service). 1990. Planning aid letter for the Sacramento River Flood Control System Evaluation, Phase III. Prepared by Ecological Services, Sacramento Field Office, Sacramento, California.

PERSONAL COMMUNICATIONS

Gaines, C. 1994. Engineer, U.S. Army Corps of Engineers. Sacramento, California.

APPENDIX F-1

ASSUMPTIONS USED IN PREDICTING FUTURE SCENARIOS

APPENDIX F-1

Assumptions used in predicting future scenarios.

General

1. HEP was a suitable methodology for quantifying project impacts to wildlife.

Future Without the Project (Impact Area)

1. Existing cover-types are:

Impact Area	Compensation Area
Riparian woodland	Agriculture/grassland
Scrub/shrub	
Emergent marsh	
Permanent wetland	
Agriculture/grassland	

2. Land uses will not change from current use; study area is largely an agricultural area.

3. Vegetation currently allowed to grow in impact areas will remain, but not increase significantly in size (acreage).

4. Emergent marsh cover-type found in the drainage ditches would not change over time from baseline conditions since they are "managed" systems.

5. No levee maintenance will occur at Site 20 (scrub-shrub cover-type) since the majority of the scrub-shrub consists of elderberry bushes. Presumably, the valley elderberry longhorn beetle, a federally threatened species, occurs at this site.

Future With the Project (Impact Area)

1. In-kind replacement of cover-type values will be sought.

2. Impacts from the project would occur in the existing permanent, temporary, and new easement areas (worse-case scenario).

3. Impact area for a cutoff wall on the levee crown (Sites 17 and 18) is restricted to the existing levee road.

4. All staging areas are within easements.

5. Construction period is a 2 full years.

6. All drainage ditches, whether dry or wet, were considered emergent marsh cover-type and all ditches were assumed seasonal.

7. Worse-case scenario was evaluated in that a cutoff wall rather than a berm/drain would be constructed.

8. All cover-types in the levee repair impact zones will be removed by construction activities.

9. All woody vegetation at construction areas, impact areas, borrow sites, and staging areas will be avoided by flagging or fencing the areas.

10. Maintenance activities on newly constructed features limits vegetation to grass species.

11. Grassland/agricultural lands impacted by the project will be reseeded to grassland after construction, requiring no additional mitigation.

12. No clear aerial photographs (i.e., color) were provided to the Service, therefore, existing cover-type acreage, such as the riparian woodland at Site 12, may have been overestimated.

13. For Site 12A, there are variable ditch widths, therefore, several sections of this site were measured, and an average width was used in determining impact acreage.

14. Most impact sites were analyzed separately. Sites 12, 13, and 15A, for emergent marsh, were analyzed together since it was determined their HSI values are the same, and Sites 5 and 19, for emergent marsh, were also analyzed together since it was determined their HSI values are also the same.

15. Although a small portion of the drainage ditch at Site 5 has water in it, a 0.0 HSI value was given since the ditch is concrete-lined (no marsh habitat would grow there, therefore, it would not be used by the evaluation species).

16. For each drainage ditch that would be relocated, a new one would be created by the Corps, and replaced at a 1:1 ratio for each impact site.

17. About 0.05 acres of permanent wetland would be impacted from levee repair activities, such as the placement of fill. It could not be

determined how much acreage of the remaining wetland cover-type would be impacted from the construction.

18. Relocated ditches will be the same width as the original ditches.

19. We expect no impacts to aquatic resources on the waterside.

20. For interceptor trench drain construction (every 300 feet), impacts from two drains (one at each end of the site) were analyzed rather than assuming only one drain would be constructed, for areas only 300 feet wide.

Future Without Management (Compensation Area)

1. Current land use will not change.
2. Current maintenance activities will not change.

Future With Management (Compensation)

1. Single, scattered trees (i.e., valley oaks) and shrubs will be replaced at a 5:1 ratio rather than be treated as a cover-type. Grasslands are of equal value to orchards as a cover-type. Impacts to these cover-types can be mitigated by reseeding with grasses after construction.

2. Compensation areas will be revegetated to develop the same cover-types lost.

3. Planting of the compensation area will be timed to coincide with the construction.

4. No compensation acreage is needed at the compensation site for emergent marsh, since, after relocating the ditches, they will be replaced on site at a 1:1 compensation ratio, plus additional acreage for enhancement.

Evaluation Species Selection

1. The species selected are good representatives of the habitat quality per each cover-type, and the changes in habitat quality relate to each evaluation species.

2. The species selected are sufficient to gauge the extent of impacts from the project.

Field Data Collection

1. The methods used to select sample sites were sufficiently random for the purposes of this study.

2. A shrub was defined as any woody, non-prostate vegetation less than or equal to 16.4 ft (5 m) tall. A tree was defined to be any woody vegetation greater than 16.4 ft tall.

APPENDIX F-2

SIs AND HSIs CALCULATED FROM BASELINE AND FUTURE ASSUMPTIONS

Suitability Indices and Habitat Suitability Indices calculated from baseline and future assumptions.

PA1 - FUTURE CONDITIONS WITHOUT THE PROJECT

EMERGENT MARSH, SITE 3
GREAT EGRET HSI MODEL

TYO -	V1	SI= 0.33	HSI = 0.32
	V2	SI= 0.3	
TY1 -	V1		HSI = 0.32
	V2		
TY2 -	V1		HSI = 0.32
	V2		
TY25	V1		HSI = 0.32
	V2		
TY52	V1		HSI = 0.32
	V2		

EMERGENT MARSH, SITE 5 & 19
GREAT EGRET HSI MODEL

TYO -	V1	SI= 0	HSI = 0
	V2	SI= 0	
TY1 -	V1		HSI = 0
	V2		
TY2 -	V1		HSI = 0
	V2		
TY25	V1		HSI = 0
	V2		
TY52	V1		HSI = 0
	V2		

EMERGENT MARSH, SITE 12, 13 & 15A
GREAT EGRET HSI MODEL

TYO -	V1	SI= 0.2	HSI = .50
	V2	SI= 0.7	
TY1 -	V1		HSI = .50
	V2		
TY2 -	V1		HSI = .50
	V2		
TY25	V1		HSI = .50
	V2		
TY52	V1		HSI = .50
	V2		

RIPARIAN WOODLAND SITE 12
NORTHERN ORIOLE HSI MODEL

TYO -	V1	SI= 1.0	HSI = .68
	V2	SI= .88	
	V3	SI= .35	
TY1 -	V1	SI= 1.0	HSI = .66
	V2	SI= .84	
	V3	SI= .35	
TY2 -	V1	SI= 1.0	HSI = .65
	V2	SI= .79	
	V3	SI= .35	
TY20	V1	SI= 1.0	HSI = .64
	V2	SI= .75	
	V3	SI= .35	
TY52	V1	SI= 1.0	HSI = .64
	V2	SI= .75	
	V3	SI= .35	

RIPARIAN WOODLAND SITE 17
NORTHERN ORIOLE HSI MODEL

TYO -	V1	SI= 1.0	HSI = .74
	V2	SI= 0.8	
	V3	SI= 0.5	
TY1 -	V1	SI= 1.0	HSI = .73
	V2	SI= .79	
	V3	SI= 0.5	
TY2 -	V1	SI= 1.0	HSI = .72
	V2	SI= .75	
	V3	SI= 0.5	
TY20	V1	SI= 1.0	HSI = .72
	V2	SI= .75	
	V3	SI= 0.5	
TY52	V1	SI= 1.0	HSI = .72
	V2	SI= .75	
	V3	SI= 0.5	

RIPARIAN WOODLAND SITE 18
NORTHERN ORIOLE HSI MODEL

TYO -	V1	SI= 0.4	HSI = .58
	V2	SI= 1.0	
	V3	SI= 0.5	
TY1 -	V1	SI= 0.5	HSI = .63
	V2	SI= 1.0	
	V3	SI= 0.5	
TY2 -	V1	SI= .62	HSI = .68
	V2	SI= 1.0	
	V3	SI= 0.5	
TY20	V1	SI= 1.0	HSI = .77
	V2	SI= 0.9	
	V3	SI= 0.5	
TY52	V1	SI= 1.0	HSI = .75
	V2	SI= .84	
	V3	SI= 0.5	

RIPARIAN WOODLAND SITE 12
YELLOW WARBLER HSI MODEL

TYO -	V1	SI= 1.0	HSI = .87
	V2	SI= 1.0	
	V3	SI= .75	
TY1 -	V1	SI= 1.0	HSI = .87
	V2	SI= 1.0	
	V3	SI= .75	
TY2 -	V1	SI= 1.0	HSI = .89
	V2	SI= 1.0	
	V3	SI= .79	
TY20	V1	SI= 0.8	HSI = .85
	V2	SI= 1.0	
	V3	SI= 0.9	
TY52	V1	SI= 0.6	HSI = .77
	V2	SI= 1.0	
	V3	SI= 1.0	

RIPARIAN WOODLAND SITE 17
YELLOW WARBLER HSI MODEL

TYO -	V1	SI= .95	HSI = .58
	V2	SI= 0.6	
	V3	SI= 0.6	
TY1 -	V1	SI= 1.0	HSI = .82
	V2	SI= 1.0	
	V3	SI= .67	
TY2 -	V1	SI= 1.0	HSI = .84
	V2	SI= 1.0	
	V3	SI= 0.7	
TY20	V1	SI= 0.8	HSI = .85
	V2	SI= 1.0	
	V3	SI= 0.9	
TY52	V1	SI= 0.7	HSI = .82
	V2	SI= 1.0	
	V3	SI= .95	

RIPARIAN WOODLAND SITE 18
YELLOW WARBLER HSI MODEL

TYO -	V1	SI= 1.0	HSI = .67
	V2	SI= 0.7	
	V3	SI= .65	
TY1 -	V1	SI= 1.0	HSI = .84
	V2	SI= 1.0	
	V3	SI= 0.7	
TY2 -	V1	SI= 1.0	HSI = .87
	V2	SI= 1.0	
	V3	SI= .76	
TY20	V1	SI= 0.8	HSI = .85
	V2	SI= 1.0	
	V3	SI= 0.9	
TY52	V1	SI= 0.7	HSI = .82
	V2	SI= 1.0	
	V3	SI= .95	

SCRUB-SHRUB SITE 20
YELLOW WARBLER HSI MODEL

TYO -	V1	SI= .95	HSI = .48
	V2	SI= 0.4	
	V3	SI= 0.6	
TY1 -	V1	SI= 1.0	HSI = .70
	V2	SI= .75	
	V3	SI= .65	
TY2 -	V1	SI= 1.0	HSI = .84
	V2	SI= 1.0	
	V3	SI= 0.7	
TY20	V1	SI= 0.8	HSI = .85
	V2	SI= 1.0	
	V3	SI= 0.9	
TY52	V1	SI= 0.7	HSI = .82
	V2	SI= 1.0	
	V3	SI= .95	

PERMANENT WETLAND SITE 17
MALLARD HSI MODEL

```
TYO - *B V1  SI= 0.5    HSI = .70
       B V2  SI= 1.0
       B V3  SI= 1.0
     **W V1  SI= 0.9
         V1  Si= 0.9

TY1 - *B V1  SI= 0.5    HSI = .70
         V2  SI= 1.0
         V3  SI= 0.6
     **W V1  SI= 0.9
         V2  SI  0.9

TY2 - *B V1  SI= 0.5    HSI = .70
         V2  SI= 1.0
         V3  SI= 0.67
     **W V1  SI= 0.9
         V2  SI  0.9

TY20  *B V1  SI= 0.5    HSI = .50
         V2  SI= 1.0
         V3  SI= 0.6
     **W V1  SI= 0.9
         V2  SI  0.5

TY52  *B V1  SI= 0.5    HSI = .40
         V2  SI= 1.0
         V3  SI= 0.6
     **W V1  SI= 0.9
         V2  SI  0.3
```

*Breeding
**Wintering

PA2 - FUTURE CONDITIONS WITH THE PROJECT

EMERGENT MARSH, SITE 3
GREAT EGRET HSI MODEL

TYO -	V1	SI=	.33	HSI = .32
	V2	SI=	.30	
TY1 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
TY2 -	V1	SI=	.33	HSI = .27
	V2	SI=	0.2	
TY3 -	V1	SI=	.33	HSI = .32
	V2	SI	0.3	
TY52	V1	SI=	0.33	HSI = .32
	V2	SI=	0.3	

EMERGENT MARSH, SITE 5 & 19
GREAT EGRET HSI MODEL

TYO -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
TY1 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
TY2 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
TY3 -	V1	SI=	.0	HSI = 0.0
	V2	SI	.0	
TY52	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	

RIPARIAN WOODLAND SITE 12
NORTHERN ORIOLE HSI MODEL

TYO -	V1	SI=	1.0	HSI = .68
	V2	SI=	.88	
	V3	SI=	.35	

*Breeding
**Wintering

```
TY1 - V1  SI=  .0        HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY2 - V1  SI=  .0        HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY20  V1  SI=  .0        HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY52  V1  SI=  .0        HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0
```

RIPARIAN WOODLAND SITE 17
NORTHERN ORIOLE HSI MODEL

```
TYO - V1  SI= 1.0        HSI = .74
      V2  SI= 0.8
      V3  SI= 0.5

TY1 - V1  SI=  .0        HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY2 - V1  SI=  .0        HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY20  V1  SI=  .0        HSI =  0.0
      V2  SI=  .0
      V3  SI=  .0

TY52  V1  SI=  .0        HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0
```

RIPARIAN WOODLAND SITE 18
NORTHERN ORIOLE HSI MODEL

```
TYO - V1  SI= 0.4        HSI = .58
      V2  SI= 1.0
      V3  SI= 0.5
```

*Breeding
**Wintering

TY1 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY2 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY20	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY52	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	

RIPARIAN WOODLAND SITE 12
YELLOW WARBLER HSI MODEL

TYO -	V1	SI=	1.0	HSI = .87
	V2	SI=	1.0	
	V3	SI=	.75	
TY1 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY2 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY20	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY52	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	

RIPARIAN WOODLAND SITE 17
YELLOW WARBLER HSI MODEL

TYO -	V1	SI=	.95	HSI = .58
	V2	SI=	0.6	
	V3	SI=	0.6	

*Breeding
**Wintering

```
TY1 - V1  SI=  .0      HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY2 - V1  SI=  .0      HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY20  V1  SI=  .0      HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY52  V1  SI=  .0      HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0
```

RIPARIAN WOODLAND SITE 18
YELLOW WARBLER HSI MODEL

```
TYO - V1  SI= 1.0      HSI = .67
      V2  SI= 0.7
      V3  SI=  .65

TY1 - V1  SI=  .0      HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY2 - V1  SI=  .0      HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0

TY20  V1  SI=  .0      HSI =  0.0
      V2  SI=  .0
      V3  SI=  .0

TY52  V1  SI=  .0      HSI = 0.0
      V2  SI=  .0
      V3  SI=  .0
```

SCRUB-SHRUB SITE 20
YELLOW WARBLER HSI MODEL

```
TYO - V1  SI=  .95     HSI = .48
      V2  SI= 0.4
      V3  SI= 0.6
```

*Breeding
**Wintering

TY1 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY2 -	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY20	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	
TY52	V1	SI=	.0	HSI = 0.0
	V2	SI=	.0	
	V3	SI=	.0	

PERMANENT WETLAND SITE 17
MALLARD HSI MODEL

TYO -	*B	V1	SI=	0.5	HSI = .25
	B	V2	SI=	1.0	
	B	V3	SI=	0.6	
	**W	V1	SI=	0.9	
		V1	Si=	0.0	
TY1 -	*B	V1	SI=	0.5	HSI = .25
		V2	SI=	1.0	
		V3	SI=	0.6	
	**W	V1	SI=	0.9	
		V2	SI	0.0	
TY2 -	*B	V1	SI=	0.5	HSI = .25
		V2	SI=	1.0	
		V3	SI=	0.6	
	**W	V1	SI=	0.9	
		V2	SI	0.0	
TY20	*B	V1	SI=	0.5	HSI = .25
		V2	SI=	1.0	
		V3	SI=	0.6	
	**W	V1	SI=	0.9	
		V2	SI	0.0	

*Breeding
**Wintering

TY52	*B	V1	SI= 0.5	HSI = .25
		V2	SI= 1.0	
		V3	SI= 0.6	
	**W	V1	SI= 0.9	
		V2	SI 0.0	

*Breeding
**Wintering

MP1 - FUTURE CONDITIONS WITHOUT MANAGEMENT

EMERGENT MARSH, SITE 3, 5, 12, 13, 15A, 19
GREAT EGRET HSI MODEL

```
TYO - V1  SI= 0         HSI = 0.0
      V2  SI= 0

TY1 - V1  SI= 0         HSI = 0.0
      V2  SI= 0

TY2 - V1  SI= 0         HSI = 0.0
      V2  SI= 0

TY25  V1  SI= 0         HSI = 0.0
      V2  SI= 0

TY52  V1  SI= 0         HSI = 0.0
      V2  SI= 0
```

RIPARIAN WOODLAND SITE 12, 17, 18
NORTHERN ORIOLE & YELLOW WARBLER

```
TYO - V1  SI= 0         HSI = 0.0
      V2  SI= 0
      V3  SI= 0

TY1 - V1  SI= 0         HSI = 0.0
      V2  SI= 0
      V3  SI= 0

TY2 - V1  SI= 0         HSI = 0.0
      V2  SI= 0
      V3  SI= 0

TY25 - V1  SI= 0        HSI = 0.0
       V2  SI= 0
       V3  SI= 0

TY52 - V1  SI= 0        HSI = 0.0
       V2  SI= 0
       V3  SI= 0
```

*Breeding
**Wintering

SCRUB-SHRUB SITE 20
YELLOW WARBLER HSI MODEL

TYO -	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY1 -	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY2 -	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY25	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY52	V1	SI= 0	HSI = 0.0
	V2	SI= 0	

PERMANENT WETLAND SITE 17
MALLARD HSI MODEL

TYO -	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY1 -	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY2 -	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY25	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY52	V1	SI= 0	HSI = 0.0
	V2	SI= 0	

*Breeding
**Wintering

MP2 - FUTURE CONDITIONS WITH MANAGEMENT

EMERGENT MARSH, SITE 3, 5, 12, 13, 15A, 19
GREAT EGRET HSI MODEL

TYO -	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
TY1 -	V1	SI= 1.0	HSI = 0.5
	V2	SI= 0	
TY10 -	V1	SI= 1.0	HSI = 0.1
	V2	SI= 1.0	
TY20	V1	SI= 1.0	HSI = 0.1
	V2	SI= 1.0	
TY52	V1	SI= 1.0	HSI = .75
	V2	SI= 0.5	

RIPARIAN WOODLAND SITE 12
NORTHERN ORIOLE HSI MODEL

TYO	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
	V3	SI= 0	
TY1	V1	SI= 0.2	HSI = .27
	V2	SI= 0.1	
	V3	SI= 1.0	
TY10	V1	SI= 1.0	HSI = 1.0
	V2	SI= 1.0	
	V3	SI= 1.0	
TY20	V1	SI= 1.0	HSI = 1.0
	V2	SI= 1.0	
	V3	SI= 1.0	
TY52	V1	SI= 1.0	HSI = .96
	V2	SI= .88	
	V3	SI= 1.0	

*Breeding
**Wintering

RIPARIAN WOODLAND SITE 12
YELLOW WARBLER HSI MODEL

TYO	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
	V3	SI= 0	
TY1	V1	SI= 0.1	HSI = .09
	V2	SI= 0.6	
	V3	SI= .14	
TY10	V1	SI= 0.3	HSI = .34
	V2	SI= 1.0	
	V3	SI= .38	
TY20	V1	SI= .68	HSI = .57
	V2	SI= 1.0	
	V3	SI= .47	
TY52	V1	SI= 1.0	HSI = .91
	V2	SI= 1.0	
	V3	SI= .82	

SCRUB-SHRUB SITE 20
YELLOW WARBLER HSI MODEL

TYO	V1	SI= 0	HSI = 0.0
	V2	SI= 0	
	V3	SI= 0	
TY1	V1	SI= 0.1	HSI = .09
	V2	SI= 0.6	
	V3	SI= .14	
TY10	V1	SI= 0.3	HSI = .34
	V2	SI= 1.0	
	V3	SI= .38	
TY20	V1	SI= .68	HSI = .57
	V2	SI= 1.0	
	V3	SI= .47	
TY52	V1	SI= 1.0	HSI = .91
	V2	SI= 1.0	
	V3	SI= .82	

*Breeding
**Wintering

PERMANENT WETLAND SITE 17
MALLARD HSI MODEL

TY0	*B	V1	SI= 0	HSI = 0.0
		V2	SI= 0	
		V3	SI= 0	
	**W	V1	SI= 0	
		V2	SI= 0	
TY1	*B	V1	SI= 0.5	HSI = .35
		V2	SI= 1.0	
		V3	SI= .53	
	**W	V1	SI= 0.2	
		V2	SI= 1.0	
TY10	*B	V1	SI= 1.0	HSI = .95
		V2	SI= 1.0	
		V3	SI= 1.0	
	**W	V1	SI= 1.0	
		V2	SI= 0.9	
TY20	*B	V1	SI= 1.0	HSI = .95
		V2	SI= 1.0	
		V3	SI= 1.0	
	**W	V1	SI= 1.0	
		V2	SI= 0.9	
TY52	*B	V1	SI= 1.0	HSI = .95
		V2	SI= 1.0	
		V3	SI= 1.0	
	**W	V1	SI= 1.0	
		V2	SI= 0.9	

*Breeding
**Wintering

APPENDIX F-3

HSI MODELS

HABITAT SUITABILITY INDEX MODEL

NORTHERN ORIOLE (Icterus spurius) BREEDING HABITAT, CENTRAL VALLEY CALIFORNIA

U.S. Fish and Wildlife Service
Division of Ecological Services
Sacramento, California

July 1985

COVER TYPE	LIFE REQUISITE	HABITAT VARIABLES
Valley woodland (W), Riparian (R)	Reproduction/Cover	Average height of deciduous tree canopy (V_1)
		Percent deciduous tree crown cover (V_2)
		Stand width (V_3)

Food

The diet of the northern oriole is comprised mainly of insects. Fruits, berries, and nectar are also utilized (Bent 1958; Martin et al. 1961). For purposes of this model, it is assumed that if suitable habitat is available for nesting and cover, food resources are not limiting.

Minimum habitat area

Minimum habitat area is defined as the minimum amount of continguous habitat that is required before an area will be occupied by a species. Based on reported pair densities (Walcheck 1970; Gaines 1974; Pleasants 1979), it is assumed that at least 0.25 acres of suitable habitat must be available for the northern oriole to occupy an area. If less than this amount is present, the HSI is assumed to be zero.

VARIABLE	HABITAT TYPE	SUGGESTED TECHNIQUE
V_1 Average height of deciduous tree canopy	R,W	Rangefinder and clinometer on belt transect
V_2 Percent deciduous tree crown cover	R,W	Line intercept
V_3 Stand width	R,W	Visual observation, aerial interpretation

HSI Determination

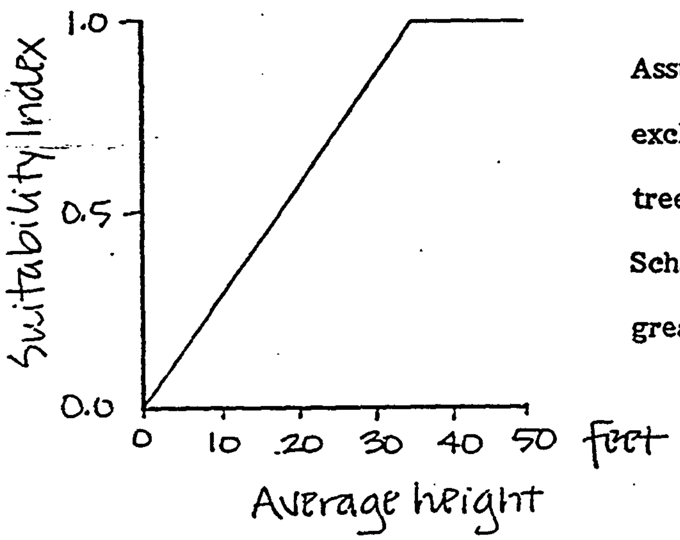
LIFE REQUISITE	COVER TYPE	EQUATION
Reproduction	R,W	$(V_1 \times V_2 \times V_3)^{1/3}$

The HSI value for the northern oriole is equal to the reproduction/cover value.

Model Applicability

The model applies to breeding habitat of the northern oriole in the Central Valley of California up to 500 feet in elevation.

1. Average height of deciduous tree canopy



Assumption: Orioles nest almost exclusively in large, preferably deciduous, trees (derived from nesting data of Schaefer (1976)). Tree height of 35 feet or greater is optimum.

HSI Determination

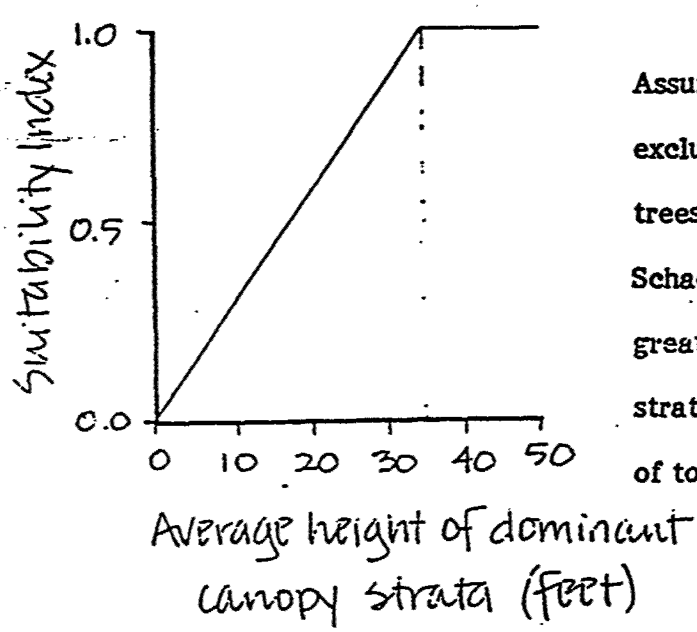
LIFE REQUISITE	COVER TYPE	EQUATION
Reproduction	R,W	$(V_1 \times V_2 \times V_3)^{1/3}$

The HSI value for the northern oriole is equal to the reproduction/cover value.

Model Applicability

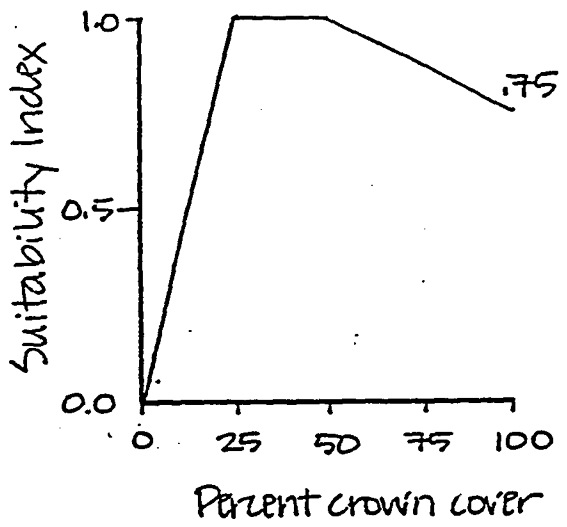
The model applies to breeding habitat of the northern oriole in the Central Valley of California up to 500 feet in elevation.

1. Average height of deciduous tree canopy



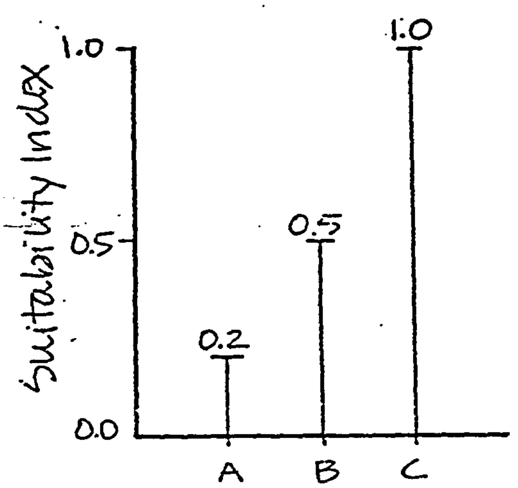
Assumption: Orioles nest almost exclusively in large, preferably deciduous, trees (derived from nesting data of Schaefer (1976)). Tree height of 35 feet or greater is optimum. The dominant canopy strata equals those trees comprising 50% of total canopy closure.

2. Percent deciduous tree crown cover.



Assumption: Orioles prefer open stands of deciduous trees for nesting (Grinnel and Miller 1944). Crown cover of 25-50% is assumed to be optimum.

3. Stand width



Assumption: Orioles prefer large blocks of riparian or oak woodland for nesting (USFWS 1981).

A - Woodland a narrow band comprising the width of one tree.
B - Woodland a strip less than 300 feet wide at its widest point.
C - Woodland greater than 300 feet wide at widest point.

Literature Cited

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FWS/OBS-82/10.27
July 1982

HABITAT SUITABILITY INDEX MODELS: YELLOW WARBLER

by

Richard L. Schroeder
Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
Drake Creekside Building One
2625 Redwing Road
Fort Collins, CO 80526

Western Energy and Land Use Team
Office of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-82/10), which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
2625 Redwing Road
Ft. Collins, CO 80526

CONTENTS

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YELLOW WARBLER (*Dendroica petechia*)

HABITAT USE INFORMATION

General

The yellow warbler (*Dendroica petechia*) is a breeding bird throughout the entire United States, with the exception of parts of the Southeast (Robbins et al. 1966). Preferred habitats are wet areas with abundant shrubs or small trees (Bent 1953). Yellow warblers inhabit hedgerows, thickets, marshes, swamp edges (Starling 1978), aspen (*Populus* spp.) groves, and willow (*Salix* spp.) swamps (Salt 1957), as well as residential areas (Morse 1966).

Food

More than 90% of the food of yellow warblers is insects (Bent 1953), taken in proportion to their availability (Busby and Sealy 1979). Foraging in Maine occurred primarily on small limbs in deciduous foliage (Morse 1973).

Water

Dietary water requirements were not mentioned in the literature. Yellow warblers prefer wet habitats (Bent 1953; Morse 1966; Stauffer and Best 1980).

Cover

Cover needs of the yellow warbler are assumed to be the same as reproduction habitat needs and are discussed in the following section.

Reproduction

Preferred foraging and nesting habitats in the Northeast are wet areas, partially covered by willows and alders (*Alnus* spp.), ranging in height from 1.5 to 4 m (5 to 13.3 ft) (Morse 1966). It is unusual to find yellow warblers in extensive forests (Hebard 1961) with closed canopies (Morse 1966). Yellow warblers in small islands of mixed coniferous-deciduous growth in Maine utilized deciduous foliage far more frequently than would be expected by chance alone (Morse 1973). Coniferous areas were mostly avoided and areas of low deciduous growth preferred.

Nests are generally placed 0.9 to 2.4 m (3 to 8 ft) above the ground, and nest heights rarely exceed 9.1 to 12.2 m (30 to 40 ft) (Bent 1953). Plants

used for nesting include willows, alders, and other hydrophytic shrubs and trees (Bent 1953), including box-elders (Acer negundo) and cottonwoods (Populus spp.) (Schrantz 1943). In Iowa, dense thickets were frequently occupied by yellow warblers while open thickets with widely spaced shrubs rarely contained nests (Kendeigh 1941).

Males frequently sing from exposed song perches (Kendeigh 1941; Ficken and Ficken 1965), although yellow warblers will nest in areas without elevated perches (Morse 1966).

A number of Breeding Bird Census reports (Van Velzen 1981) were summarized to determine nesting habitat needs of the yellow warbler, and a clear pattern of habitat preferences emerged. Yellow warblers nested in less than 5% of census areas comprised of extensive upland forested cover types (deciduous or coniferous) across the entire country. Approximately two-thirds of all census areas with deciduous shrub-dominated cover types were utilized, while shrub wetland types received 100% use. Wetlands dominated by shrubs had the highest average breeding densities of all cover types [2.04 males per ha (2.5 acre)]. Approximately two-thirds of the census areas comprised of forested draws and riparian forests of the western United States were used, but average densities were low [0.5 males per ha (2.5 acre)].

Interspersion

Yellow warblers in Iowa have been reported to prefer edge habitats (Kendeigh 1941; Stauffer and Best 1980). Territory size has been reported as 0.16 ha (0.4 acre) (Kendeigh 1941) and 0.15 ha (0.37 acre) (Kammeraad 1964).

Special Considerations

The yellow warbler has been on the Audubon Society's Blue List of declining birds for 9 of the last 10 years (Tate 1981).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model has been developed for application within the breeding range of the yellow warbler.

Season. This model was developed to evaluate the breeding season habitat needs of the yellow warbler.

Cover types. This model was developed to evaluate habitat in the dominant cover types used by the yellow warbler: Deciduous Shrubland (DS) and Deciduous Scrub/Shrub Wetland (DSW) (terminology follows that of U.S. Fish and Wildlife Service 1981). Yellow warblers only occasionally utilize forested habitats and reported population densities in forests are low. The habitat requirements in forested habitats are not well documented in the literature. For these reasons, this model does not consider forested cover types.

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Information on the minimum habitat area for the yellow warbler was not located in the literature. Based on reported territory sizes, it is assumed that at least 0.15 ha (0.37 acre) of suitable habitat must be available for the yellow warbler to occupy an area. If less than this amount is present, the HSI is assumed to be 0.0.

Verification level. Previous drafts of the yellow warbler habitat model were reviewed by Douglass H. Morse and specific comments were incorporated into the current model (Morse, pers. comm.).

Model Description

Overview. This model considers the quality of the reproduction (nesting) habitat needs of the yellow warbler to determine overall habitat suitability. Food, cover, and water requirements are assumed to be met by nesting needs.

The relationship between habitat variables, life requisites, cover types, and the HSI for the yellow warbler is illustrated in Figure 1.

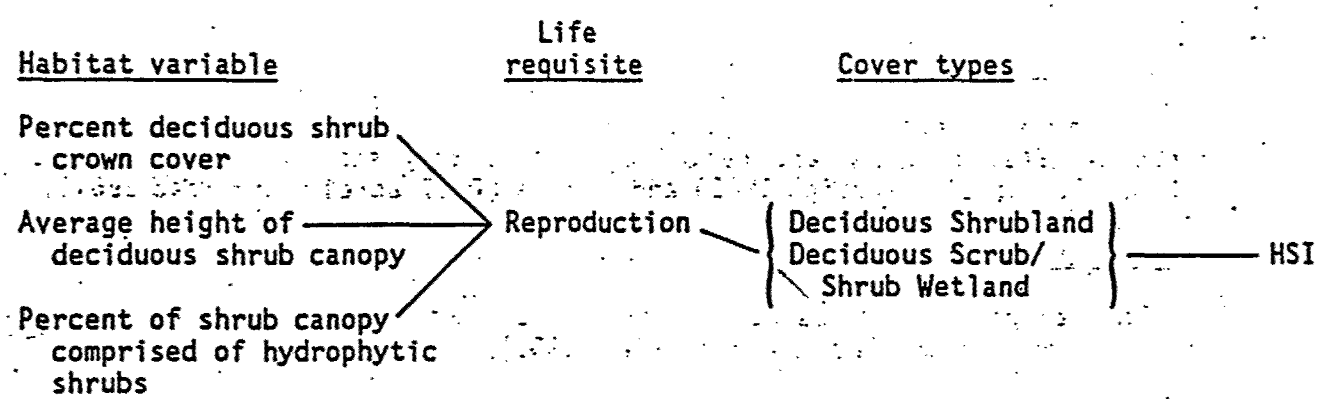


Figure 1. Relationship between habitat variables, life requisites, cover types, and the HSI for the yellow warbler.

The following sections provide a written documentation of the logic and assumptions used to interpret the habitat information for the yellow warbler and to explain and justify the variables and equations that are used in the HSI model. Specifically, these sections cover the following: (1) identification of variables that will be used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationship between variables.

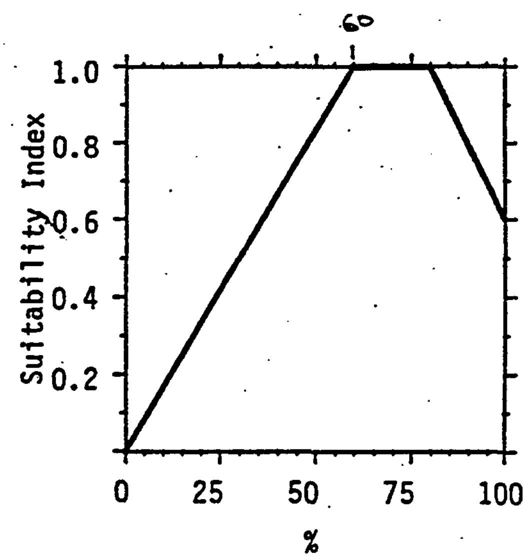
Reproduction component. Optimal nesting habitat for the yellow warbler is provided in wet areas with dense, moderately tall stands of hydrophytic deciduous shrubs. Upland shrub habitats on dry sites will provide only marginal suitability.

It is assumed that optimal habitats contain 100% hydrophytic deciduous shrubs and that habitats with no hydrophytic shrubs will provide marginal suitability. Shrub densities between 60 and 80% crown cover are assumed to be optimal. As shrub densities approach zero cover, suitability also approaches zero. Totally closed shrub canopies are assumed to be of only moderate suitability, due to the probable restrictions on movement of the warblers in those conditions. Shrub heights of 2 m (6.6 ft) or greater are assumed to be optimal, and suitability will decrease as heights decrease to zero.

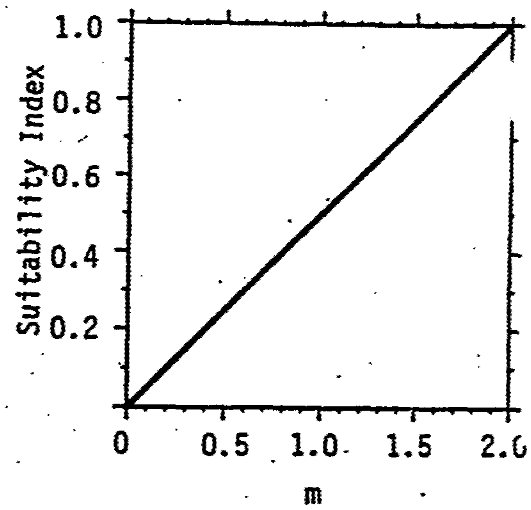
Each of these habitat variables exert a major influence in determining overall habitat quality for the yellow warbler. A habitat must contain optimal levels of all variables to have maximum suitability. Low values of any one variable may be partially offset by higher values of the remaining variables. Habitats with low values for two or more variables will provide low overall suitability levels.

Model Relationships

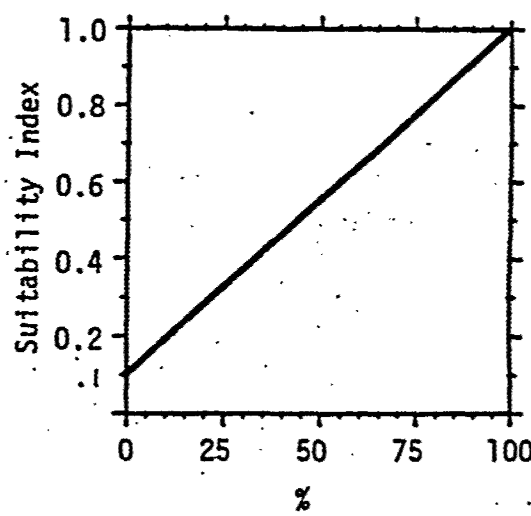
Suitability Index (SI) graphs for habitat variables. This section contains suitability index graphs that illustrate the habitat relationships described in the previous section.

Cover type	Variable		
DS,DSW	V_1	Percent deciduous shrub crown cover.	

DS,DSW V$_2$ Average height of deciduous shrub canopy.



DS,DSW V$_3$ Percent of deciduous shrub canopy comprised of hydrophytic shrubs.



Equations. In order to obtain life requisite values for the yellow warbler, the SI values for appropriate variables must be combined with the use of equations. A discussion and explanation of the assumed relationship between variables was included under Model Description, and the specific equation in this model was chosen to mimic these perceived biological relationships as closely as possible. The suggested equation for obtaining a reproduction value is presented below.

Life requisite	Cover type	Equation
Reproduction	DS,DSW	$(V_1 \times V_2 \times V_3)^{1/2}$

HSI determination. The HSI value for the yellow warbler is equal to the reproduction value.

Application of the Model

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 2.

Variable (definition)		Cover types	Suggested technique
V_1	Percent deciduous shrub crown cover (the percent of the ground that is shaded by a vertical projection of the canopies of woody deciduous vegetation which are less than 5 m (16.5 ft) in height).	DS,DSW	Line intercept
V_2	Average height of deciduous shrub canopy (the average height from the ground surface to the top of those shrubs which comprise the uppermost shrub canopy).	DW,DSW	Graduated rod
V_3	Percent of deciduous shrub canopy comprised of hydrophytic shrubs (the relative percent of the amount of hydrophytic shrubs compared to all shrubs, based on canopy cover).	DS,DSW	Line intercept

Figure 2. Definitions of variables and suggested measurement techniques.

SOURCES OF OTHER MODELS

No other habitat models for the yellow warbler were located.

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Drake Creekside Building One
2625 Redwing Road
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Habitat preferences of the yellow warbler (Dendroica petechia) are described in this publication. It is one of a series of Habitat Suitability Index (HSI) models and was developed through an analysis of available information on the species-habitat requirements of the species. Habitat use information is presented in a review of the literature, followed by the development of an HSI model, designed for use in impact assessment and habitat management activities.

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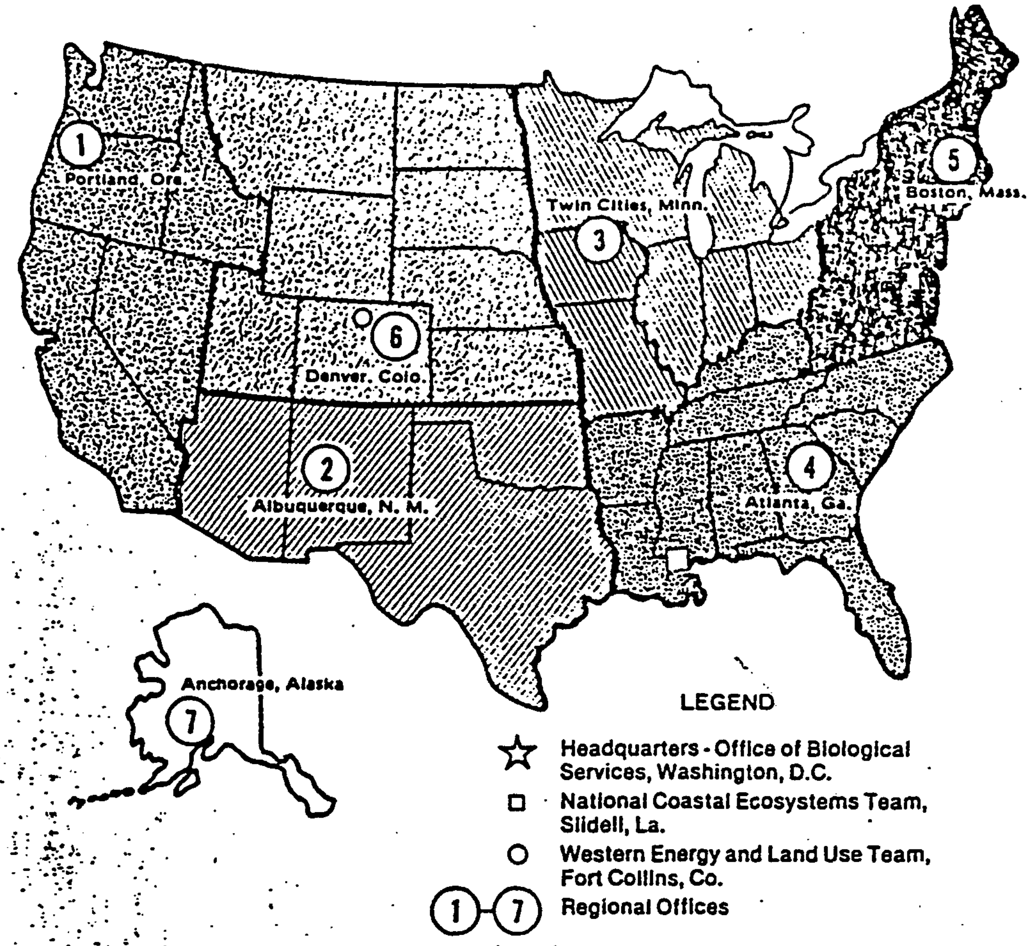

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DRAFT
August 1980

5.0 MALLARD

General

The mallard duck (Anas platyrhynchos) is California's most abundant breeding duck and is exceeded in winter numbers only by pintails and American wigeon (Kozlik, 1974). From 1973 to 1977, the Central Valley mallard population averaged 414,872 in mid-winter census counts; 95% of the California population (435,421) and 28% of the Pacific Flyway population (1,468,332; FWS 1977). Seventy-seven percent of the mid-winter Central Valley population occurs in the Sacramento Valley, 5 percent in the Suisun Marsh - Delta region and 18 percent in the San Joaquin Valley. Mallards are most abundant in Ecoregion 2610 from October through March (Cogswell 1977).

Throughout Ecoregion 2610, mallards are very common to abundant in marshes, ponds, shallow lakes and wet grasslands and fields; common in lakes or ponds of urban parks (Cogswell 1977).

Food Requirements

The mallard is about 90 percent vegetarian (McAtee 1918, in Bent 1951; Martin et al. 1961) where aquatic insects comprise most of the remaining diet (Martin et al. 1961). Primarily a fresh water duck, mallards prefer feeding in "..... sloughs, ponds, lakes, streams and swamps of the interior, where their food in picked up on or above the surface or obtained by partial immersion in shallow water" (Bent 1951). Mallards will sometimes leave these quiet, shallow waters for upland areas to feed on corn, wheat and rice (Madson 1960; Martin et al. 1961) and oats, acorns, sorghum and alfalfa (Martin et al. 1961).

Within Ecoregion 2610, food habits of the mallard are summarized as follows (Bruce Browning, California Department of Fish and Game; unpubl. data):

FOOD HABITS OF MALLARDS IN THE CENTRAL VALLEY BY REGION

Sacramento Valley		Suisun Marsh		San Joaquin Valley	
Food Type	Percent	Food Type	Percent	Food Type	Percent
Rice	33.1	Alkali bulrush	25.0	Watergrass	32.0
Watergrass	21.2	Cult. barley	19.7	Rice	12.0
Bulrushes	10.4	Corn	6.8	Smartweeds	8.6
Smartweeds	6.4	Milo	6.1	Vegetative fgmts.	5.6
Vegetative fgmts.	4.7	Fat-hen	5.4	Yellow water weed	3.8
Arrowhead sds, tubers	3.3	Pondweed	4.7	Jointgrass	3.7
Sprangle-top	2.8	Pickleweed	3.5	Clover fern sporocarps	3.6
Grass leafage	2.3	Ryegrass	3.2	Sprangle-top	3.4
Alkali bulrush	2.1	Knotweed	2.7	Animal food	3.0
Dock	1.6	Watergrass	2.7	Spikerushes	2.8
Spikerush	1.1	Vegetative stem fgmts	2.3	Cult. barley	2.3
Nutgrass	1.1	Dock	2.2	Saltbushes	2.2
Animal food	1.1	Cult. oats	2.0	Pondweeds	2.1
Misc. food items	8.8	Smartweeds	1.9	Arrowhead	1.7
		Animal food	1.5	Wild barley	1.6
		Wheat	1.5	Alkali bulrush	1.5
		Rice	1.3	Grass leafage	1.2
		Bulrush	1.3	Docks	1.1
		Arrowhead	1.2	Misc. food items	7.8
		Grass leaf, stems	1.2		
		Beardgrass	1.1		
		Misc. food items	2.7		
(n = 426)		(n = 208)		(n = 283)	

Water Requirements

Mallard ducklings exhibit a limited salinity tolerance in drinking water (McFarland). Ducklings utilized water with 0.5 percent NaCl (5,000 ppm) with no ill effects. However, drinking water concentrations of 1.0 percent NaCl (10,000 ppm) yields moderate salt toxicity mortality, while 1.5 percent NaCl (15,000 ppm), or greater, was uniformly fatal. Availability of food during the first few weeks of life is critical since ducklings in a saline environment will eat greater amounts, thus producing more metabolic water to balance the higher salt accumulation in their bodies. This tends to minimize salt related mortality when drinking water salinity ranges from 0.5 to 1.0 percent NaCl (5,000 to 10,000 ppm).

Water salinity is probably only a problem in Suisun Marsh, the Grasslands, southern San Joaquin Valley and any other area where the water regime allows the buildup of salts during the breeding season of the Mallard. Salinity management suggestions can be obtained from the local District Conservationist of the USDA-Soil Conservation Service.

Cover Requirements

Mallards may be found wintering wherever food and open water are available (Johnsgard 1975). Mallards are capable of escaping many predators by outflying or outswimming them and by diving beneath the water's surface for short periods (Madson 1960). Mallards may also hide in dense marsh vegetation; especially during late summer, for drakes, or early fall for hens, when flight feathers are moulted and they are particularly vulnerable to danger (Grinnell et al. 1918; Bent 1951; Madson 1960). These birds may also rely on cryptic coloration to conceal themselves (Grinnel et al. 1918; Bent 1951).

Nest cover requirements of mallard ducks are addressed under reproductive requirements; see below.

Reproductive Requirements

Preferred and acceptable breeding habitats are difficult to separate, since mallards breed over a broad range, yet some trends are evident (Johnsgard 1975). Availability of suitable nest sites and shallow-water feeding areas appear to be the only limitations. Lee et al. (1964, in Johnsgard 1975) reports a preference for mallards to nest in fairly dry sites with rather tall vegetation, as in dry marshes, upland weeds, or hayfields. As elsewhere, California mallards tend to nest in tall cover (Miller and Collins 1954; Anderson 1960; Rienecker and Anderson 1960; Wheeler and Harris 1970). On the Tule Lake and Lower Klamath Refuges, mallards showed a preference for vegetation 33.0 to 61.0 cm (13 to 24 inches), where over half of all nests were concealed on all four sides plus overhead (Miller and Collins 1954).

The greater the breeding population is, the greater the distance mallards will nest from water (Dzubin and Gollop 1972, in Bellrose 1976). Mallards may fly up to five miles from water, when choice nesting cover is distant (Duebbert 1969, in Bellrose 1976). Ball et al. (1975) studied mallard and wood duck broods in Minnesota and observed a negative correlation between duckling survival and distance of overland travel. Broods hatched in nests less than 0.8 km (0.5 mi) from water realized a greater survival rate than those more distant. Anderson (1956, 1957, 1960) reports the following distances from nest sites to water for the three main regions of Ecoregion 2610: (next page).

NEST SITE DISTANCE TO WATER

	< 3 yd (≤2.7 m)	4-50 yd (3.7-45.7 m)	51-100 yd (46.6-91.4 m)	>100 yd (>91.4m)	Total
Suisun Marsh	25.9%	63.0%	3.7%	7.4%	100%
San Joaquin Valley	14.5%	43.0%	18.0%	24.5%	100%
Sacramento Valley	40.0%	20.7%	14.4%	24.9%	100%
Mean	26.8%	42.3%	12.0%	18.9%	100%
Cummulative Mean	26.8%	69.1%	81.1%	100%	

These three studies of waterfowl nesting in Ecoregion 2610 (Anderson 1956, 1957, 1960) also yield the following nest site and cover selections by mallards (percentage of nests found in each category):

NEST SITE SELECTION

	Dike 1/	Island 2/	Marsh	Grainfield or Pasture	Uncult. or Fallow Field	Total
Suisun Marsh	22.2%	NS 3/	55.6%	NS	22.2%	100%
San Joaquin Valley	1.5%	6.5%	NS	81.0%	11.0%	100%
Sacramento Valley	43.9%	NS	NS	21.3%	34.8%	100%

1/ Roadside, levee and rice check embankments.
2/ Any raised area, completely surrounded by water.
3/ NS - not a sampled catagory in respective study.

NEST COVER SELECTION

	Rush (Juncus)	Pickleweed (Salicornia)	Grasses and/or Sedges	Barley	Cattail (Typha)	Other	Total
Suisun Marsh	55.6%	14.8%	7.4%	NS 1/	NS	22.2%	100%
San Joaquin Valley	89.5%	NS	8.8%	NS	0.1%	1.6%	100%
Sacramento Valley	9.9%	NS	35.4%	33.3%	2.1%	19.3%	100%

1/ NS - not a sampled catagory in respective study.

In an agricultural setting near Woodland (Sacramento Valley), Earl (1950) observed nest site selections by mallard as follows: wheat fields (43%), ditchbanks and roadsides (22%), irrigated pasture (12%), fallow pasture (8%), rice fields (7%), tule swales (5%) and barley fields (3%).

Within 12 hours after hatching, the hen mallard leads her brood to water; usually less than several hundred yards away, but on occasion, one to several miles (Bellrose 1976). Hen mallards perfer to nurse their broods in deep marshes (though depth is not required) with dense, undisturbed cover vegetation on margins of open-water areas (Evans 1951, in Madson 1960).

Special Habitat Requirements

No information on special habitat requirements were found in the literature.

Interspersion Requirements

No information on interspersion requirements were found in the literature.

Special Considerations

As reclamation projects developed more and more agicultural land, from waterfowl habitat, crop damage steadily increased in the Central Valley (Biehn 1951). One role of wetland management, therefore, is to deter these depredations by attracting waterfowl to feed in the private, state and federally owned wetlands (FWS 1977).

As are many avian species, mallards are adversely effected by environmental contaminants. Hypothermia (drop in core body temperature) results in mallards utilizing cold, detergent polluted water (Choules et al. 1978). Petroleum oil (Szaro 1978) and DDT (Kolaja and Hinton 1979) reduce hatchability of mallard eggs. Ingestion of lead pellets, from shotgun shells, is toxic to mallards (Longcore et al. 1974; Roscoe and Nielson 1979). Bottom samples of Central Valley marshes, which receive extensive use by waterfowl, reveal an average of 34,848 pellets per acre (FWS 1976). Approximately seven percent of over 17,000 examined mallard gizzards contained one or more pellets. To replace lead pellets, steel shot has been recommended by the U.S. Fish and Wildlife Service (1976) for hunting waterfowl in areas where lead poisoning poses a threat.

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GUIDELINES FOR DETERMINING HABITAT SUITABILITY INDEX (HSI)

Species: Mallard (Anas platyrhynchos)
Cover Type: Herb Dominated Wetlands
Ecoregion: 2610 - The Central Valley of California

HABITAT RELATIONSHIPS

Range Size

Varies, depending upon the condition of the habitat and the density of the breeding population. Home range of a breeding pair may exceed 283.3 ha (700 ac) with a considerably smaller territory. In winter, mallards flock together to feed and rest in shallow ponds, lakes and wetlands. They may fly up to 64.4 km (40 mi) to feed in cultivated upland fields; though distances of 40.2 km (25 mi) are more common.

Optimum Habitat Composition

Mallards are eurytopic, requiring only the presence of shallow-water feeding areas and suitable nest sites. Mallards frequent fresh water lakes, ponds, rivers, marshes, streams, sloughs and wet or irrigated hayland, grainfields, pasture and grasslands.

Life Requisite Values

Food - Related to the abundance and availability of marsh and aquatic plants; also farm crops such as corn, sorghum, barley, wheat and rice.

Water - Related to the salinity of available drinking water during the fledging period.

Cover - Open water with margins of dense wetland vegetation are preferred, but only facultative throughout most of the year.

Reproduction - Related to the availability of fairly dry nest sites, with rather tall, dense vegetation, near shallow water or agricultural feeding areas.

Mechanism to Determine the Habitat Suitability Index (HSI)

Three HSI values will be developed for the mallard. The Breeding Habitat Suitability Index (BHSI) relates the suitability of the sample site to fulfill the needs of the resident population, during the breeding season only. The Winter Habitat Suitability Index (WHSI) shall relate the sample site's fulfillment of Life Requisites for both resident and migratory mallards during the nonbreeding period; including the fall and spring migrations. The Habitat Suitability Index (HSI - without modifier) is then computed as the mean of both the BHSI and WHSI to reflect the overall ability of the sample site to meet all of the resident population's needs to complete their annual cycle. The BHSI and WHSI are each based on their lowest respective Life Requisite Values.

Breeding Habitat Suitability Index (BHSI $\leq$ 1.0) = ___________

Wintering Habitat Suitability Index (WHSI $\leq$ 1.0) = ___________

Habitat Suitability Index (HSI $\leq$ 1.0) = (BHSI + WHSI) $\div$ 2

= _______________

HABITAT EVALUATION CRITERIA

Breeding Habitat Evaluation Criteria (BHSI)

Food - Related primarily to the abundace and availability of marsh and aquatic vegetation and/or upland crops including rice, barley, wheat, milo, corn and oats. (See Food in narrative for detailed description of regional food habits.)

Food Value is a function of:

[V_1] The abundance and availability of suitable food types within 0.9 km (0.6 mi) of sample site.

(a) Suitable food types abundant and readily available . . . . (0.8 - 1.0 rating)

(b) Suitable food types scattered, less abundant (medium density), or less available (concentrated at a distance from the sample site, not exceeding 0.9 km - or 0.6 mi) . . . . (0.3 - 0.7 rating)

(c) Suitable food types scarce or unavailable within 0.9 km (0.6 mi) . . . . (0.0 - 0.2 rating)

Food Value [V_1] = ____________

Water - Related primarily to the salinity of available drinking water during the fledging period; early March to late July. The mallard brood is highly susceptable to salt intoxication and death, when drinking water has high concentrations of salt. Moderate mortality is expected where salt concentrations range from 0.5-1.0 percent. This may be offset by an abundant supply of food since ducklings in saline environments will eat more food and produce more metabolic water. Concentrations exceeding 1.0 percent will result in up to 100 percent brood mortality. If water on or near the sample site is decidedly fresh, a qualitative evaluation is adequate. However, use of a salinity test kit is recommended where doubt arises regarding water freshness. The following conversions allow for differences in field kits and relate to the principal salinity concentrations in the analysis, 0.5 and 1.0 percent:

Percentage (%)	Molarity (M)	Parts/Thous. (0/00)	Parts/Mill. (ppm)	Elec. Conduc. (mmhos)
0.5	0.086M	5	5,000	7.5
1.0	0.172M	10	10,000	15.0

Water Value is a function of:

[V_2] The presence of fresh drinking water for mallard broods (or the degree of salinity) on, adjacent to, or near the sample site. Consider the year-around water regime; i.e., fluctuation effects on water level during the fledging period.

(a) Water is decidely fresh;
$\leq$0.5% saline . . . . (0.8 - 1.0 rating)

(b) % salinity between 0.5 - 1.0 . . . . . . (0.3 - 1.0 rating)

(c) % salinity >1.0 . . . . (0.0 - 0.2 rating)

Water Value [V_2] = ______________

<u>Reproduction</u> - Related to the availability of dry nest sites with tall, dense cover vegetation -and- the distance to water.

<u>Reproduction Value</u> is the weighted mean of the following:

[V_3] A. <u>Suitable nest sites</u> consist of dry areas with tall, dense cover vegetation including dikes, islands (however small), cultivated grainfields and pasture or upland fields of natural fallow vegetation. In the Sacramento Valley, grasses and sedges were preferred nesting cover, while rushes (<u>Juncus</u> spp.) were favored in the San Joaquin Valley and Suisan Marsh.

(a) Suitable nest sites abundant with dense vegetation 33.0 - 61.0 cm (13.0 - 24.0 in) tall . . . . (0.8 - 1.0 rating)

(b) Suitable nest sites scattered and/or vegetation of medium density (an empirical estimate) and/or vegetation $\leq$30.5 cm (12.0 in) tall or less . . . . (0.4 - 0.7 rating)

(c) Suitable nest sites lacking and/or vegetation sparse and/or vegetation 63.5 cm (25.0 in) or taller . . . . (0.0 - 0.3 rating)

Suitable Nest Site Value (A) = ___________

B. Distance to Water from sample site, or area within which preferred nest sites occur.

(a) 3.7-45.7 m (4.0-50.0 yd) . . . . . (0.8 - 1.0 rating)

(b) <3.7 m (4.0 yd) . . . . (0.5 - 0.7 rating)

(c) >45.7 m (50.0 yd) . . . . (0.0 - 0.4 rating)

Distance to Water Value (B) = ________

Reproduction Value [V_3] = (2A + B) ÷ 3

V_3 = ________

Other Considerations

In addition to those inventory characteristics identified as being important for the mallard, there may still be other pertinent evaluation criteria obvious only at an on-site inspection. All criteria identified as being unique to a specific site must be incorporated (and documented) into the appropriate life requisite category as each situation dictates and considered when determining the HSI.

If any criteria listed are not applicable in a particular situation, do not use in determining the life requisite value or the HSI.

Breeding Habitat Suitability Index (BHSI) equals the lowest Life Requisite Value BHSI ($\leq$ 1.0) = ________

Wintering Habitat Evaluation Criteria (WHSI)

Food - Related primarily to the abundance and availability of marsh and aquatic vegetation and/or upland fields of rice, barley, wheat, milo, corn and oats. (See Food in narrative for detailed description of regional food habits.)

While wintering, mallards frequently fly up to 40.2 km (25.0 mi) to feed in agricultural fields. The gross interspersion of these fields with wetlands and the mobility of mallards yield great, but temporary importance of croplands to this bird; i.e., wintering mallards may feed in a field of barley during mid-day hours, return to rest in some distant marsh and not recur in said field for the remainder of the season. Also, small ponds, streams, sloughs and impoundments may provide temporary rest to migrating mallards, adjacent to agricultural fields for feeding. Hence, consider the surrounding environs, within 40.2 km (25.0 mi) of the area and the seasons of potential use, while judging the food value of the sample site.

Food Value is a function of:

[V_1] The abundance and availability of marsh and aquatic vegetation (natural or managed) within 1.6 km (1.0 mi) from sample site and/or the abundance and availability of described agricultural fields within 40.2 km (25.0 mi) from sample site. Availability of marsh vegetation also includes depth of submergence. Flooded vegetation should not exceed 38.1-45.7 cm (15.0-18.0 in) distance beneath the surface, thus being easily accessible to mallards and other dabblers.

(a) Suitable food types abundant and readily available (within prescribed distances from sample site; available within 30.5 cm, or 12.0 in, beneath surface) . . . . (0.8 - 1.0 rating)

(b) Suitable food types scattered, less abundant (medium density), or less available (concentrated towards distal end of distance limits from sample site; food submerged 33.0 - 45.7 cm, or 13.0 - 18.0 in, beneath surface . . . . (0.3 - 0.7 rating)

(c) Suitable food types scarce or unavailable (beyond distance limits or submerged beyond 45.7 cm, or 18.0 in, beneath surface) . . . . (0.0 - 0.2 rating)

Food Value [V_1] = ______________

Cover - Related to the presence of shallow to moderately deep open water. Such areas should consist of fresh water; i.e. permanent wetlands with circulating water or seasonal wetlands where flooding occurs just prior to the influx of wintering flocks. Preferred areas are open bodies of water with scattered, thin stands of emergent vegetation (e.g., cattail and tule).

Cover Value is a function of:

[V_2] The presence of open bodies of water and the density and interspersion of emergent vegetation.

(a) Surface area of water greatly exceeds surface

area of emergent vegetation; emergents occur as scattered stands along margins . . . . (0.9 - 1.0 rating)

(b) Surface area of open water approximately equals surface area of emergent vegetative cover; density of emergents is low - i.e., scattered clumbs or thinly dispersed . . . . (0.6 - 0.8 rating)

(c) Same as (b), but density of emergents is high . . . . (0.4 - 0.5 rating)

(d) Surface area of emergent vegetation greatly exceeds surface area of open water (density of emergent vegetation can be used to determine value with the following range, where high density is of lowest value) . . . . (0.0 - 0.3 rating)

Cover Value [V_2] = ________________

Other Considerations

In addition to those inventory charcteristics identified as being important for the mallard, there may still be other pertinent evaluation criteria obvious only at an on-site inspection. All criteria identified as being unique to a specific site must be incorporated (and documented) into the appropriate life requisite category as each situation dictates and considered when determining the HSI.

If any criteria listed are not applicable in a particular situation, do not use in determining the life requisite value or the HSI.

Wintering Habitat Suitability Index (WHSI) equals the lowest Life Requisite Value WHSI ($\leq$1.0) = __________

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HABITAT SUITABILITY INDEX MODELS: GREAT EGRET

by

Brian R. Chapman
Department of Biology
Corpus Christi State University
Corpus Christi, TX 78412

and

Rebecca J. Howard
National Coastal Ecosystems Team
U.S. Fish and Wildlife Service
1010 Gause Boulevard
Slidell, LA 70458

Project Officer

Paul L. Fore
Regional Office, Region 2
U.S. Fish and Wildlife Service
Albuquerque, NM 87103

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National Coastal Ecosystems Team
Division of Biological Services
Research and Development
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

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PREFACE

The habitat suitability index (HSI) model for the great egret presented in this report is intended for use in the habitat evaluation procedures (HEP) developed by the U.S. Fish and Wildlife Service (1980) for impact assessment and habitat management. The model was developed from a review and synthesis of existing information and is scaled to produce an index of habitat suitability between 0 (unsuitable habitat) and 1.0 (optimally suitable habitat). Assumptions used to develop the HSI model and guidelines for model applications, including methods for measuring model variables, are described.

This model is a hypothesis of species-habitat relations, not a statement of proven cause and effect. The model has not been field tested, but it has been applied to three hypothetical data sets that are presented and discussed. The U.S. Fish and Wildlife Service encourages model users to convey comments and suggestions that may help increase the utility and effectiveness of this habitat-based approach to fish and wildlife management. Please send any comments or suggestions you may have on the great egret HSI model to the following address.

National Coastal Ecosystems Team
U.S. Fish and Wildlife Service
1010 Gause Boulevard
Slidell, LA 70458

CONTENTS

ACKNOWLEDGMENTS

Earlier versions of the habitat suitability index model and narrative for the great egret were reviewed by Dr. R. Douglas Slack and Jochen H. Wiese. The model's structure and functional relationships were thoroughly evaluated by personnel of the U.S. Fish and Wildlife Service's (FWS) National Coastal Ecosystems Team. Model and narrative reviews were also provided by FWS Regional personnel.

GREAT EGRET (*Casmerodius albus*)

INTRODUCTION

The great egret, also called common egret or American egret, is a large white heron in the order Ciconiiformes, family Ardeidae. Great egrets stand 94.0-104.1 cm (37-41 inches) tall and have a wing spread to 139.7 cm (55 inches) (Terres 1980). The species is associated with streams, ponds, lakes, mud flats, swamps, and freshwater and salt marshes. The birds feed in shallow water on fishes, amphibians, reptiles, crustaceans and insects (Terres 1980).

Distribution

The great egret is a common breeding species in all coastal areas south from southern Oregon on the Pacific coast and from Maine on the Atlantic coast; in riverine, palustrine and estuarine habitats along the coast of the Gulf of Mexico; and in the Eastern-Central United States (Palmer 1962; Erwin and Korschgen 1979; American Ornithologists' Union 1983). The great egret undergoes an extensive postbreeding dispersal that extends the range of the species to most of the United States exclusive of the arid Southwest (Byrd 1978). Young birds hatched in Gulf coast colonies tend to move northward for a short period (Byrd 1978; Ogden 1978). However, with the onset of colder weather most great egrets and other herons migrate south and many winter along the gulf coast in Texas, Louisiana, and Florida (Lowery 1974; Oberholser and Kincaid 1974; Byrd 1978). Analysis of banding data indicates that many birds winter in Cuba, the Bahamas, the Greater and Lesser Antilles, Mexico, and Central America (Coffey 1948). Lowery (1974) suggested that during severe winters, a higher proportion of the population winters farther south.

Life History Overview

Great egrets nest in mixed-species colonies that number from a few pairs to thousands of individuals. A colony may include other species of herons, spoonbills, ibises, cormorants, anhingas, and pelicans. Colony and nest-site selections begin as early as December along the gulf coast, but most great egrets do not initiate nesting activities until mid-February or early March (Bent 1926; Oberholser and Kincaid 1974; Chaney et al. 1978; Morrison and Shanley 1978). Eggs have been recorded from March through early August, and young have been observed in nests from mid-May through late August (Oberholser and Kincaid 1974; Chaney et al. 1978). Clutch size varies from one to six eggs per nest, but three to four eggs is most common (Bent 1926). Incubation period in a Texas colony ranged from 23 to 27 days (Morrison and Shanley 1978). The first flights of young have been noted about 42 days after hatching (Terres 1980).

SPECIFIC HABITAT REQUIREMENTS

Food and Foraging Habitat

Fish constitute up to 83% of the great egret's diet (Hoffman 1978). Most fish taken by great egrets are minnow-sized (less than 10 cm or 3.9 inches), but fish up to 36 cm (14 inches) can be captured and swallowed (Willard 1977; Schlorff 1978). Other major food items include insects, crustaceans, frogs, and snakes, while small mammals, small birds, salamanders, turtles, snails, and plant seeds are occasionally taken (Baynard 1912; Bent 1926; Hunsaker 1959; Palmer 1962; Genelly 1964; Kushlan 1978b).

Little specific information exists on the food habits of various age classes of great egrets. An adult great egret weighing 917 g (32.3 oz) (Palmer 1962) may require approximately 110 g (3.9 oz) of food per day (estimated by using the wading bird weight-daily food requirement model proposed by Kushlan 1978b). Daily food requirements are undoubtedly higher during the nesting season when adults are feeding young (Kushlan 1978b).

Great egrets usually forage in open, calm, shallow water areas near the margins of wetlands. They show no preference for fresh-, brackish, or saltwater habitat. Custer and Osborn (1978a,b) found that feeding habitat selection in coastal areas of North Carolina varied daily with the tidal cycle. During low tide, great egrets fed in estuarine seagrass beds. During high tide, freshwater ponds and the margins of _Spartina_ marshes were used. Inland, great egrets feed near the banks of rivers or lakes, in drainage ditches, marshlands, rain pools (Bent 1926; Dusi et al. 1971; Kushlan 1976b), and occasionally in grassy areas (Weise and Crawford 1974). Feeding sites are generally not turbid and are fairly open with no vegetative canopy and few emergent shoots (Thompson 1979b).

Great egrets forage singly, in single-species groups, and in mixed-species associations (Kushlan 1978b). Great egrets generally fly alone to feeding sites (Custer and Osborn 1978a,b) and may use the same feeding site repeatedly. The density and abundance of fish at a given location in estuarine habitats may vary with season, time of day, tidal stage, turbidity, and other factors. If feeding success is low, great egrets may move to other areas (Cypert 1958; Schlorff 1978) and join other conspecifics in good feeding habitats (Custer and Osborn 1978a,b). Most instances of group feeding have been observed during specific environmental conditions, such as lowered water levels, that tend to concentrate prey (Kushlan 1976a,b; Schlorff 1978).

Meyerriecks (1960, 1962) and Kushlan (1976a, 1978a,b) provided detailed information on hunting techniques employed by great egrets. The "stand-and-wait" and "slow-wade" methods are used most frequently. Because of their long legs, great egrets can forage in somewhat deeper water than most other herons. In New Jersey, foraging depths ranged from 0 (standing on the bank while fishing) to 28 cm (11 inches), but depths ranging from 10 cm to 23 cm (4 to 9 inches) were most commonly used (Willard 1977). In North Carolina, great egrets fed in water with a mean depth of 25.1 cm (9.8 inches) in _Spartina_ habitat and of 17.4 cm (6.8 inches) in non-_Spartina_ habitat (Custer and Osborn 1978b). Mean water depth was 20 cm (7.9 inches) for

foraging great egrets in California (Hom 1983). In addition to wading, great egrets can feed by alighting on the surface of deep waters to catch prey, a method rarely employed (Reese 1973; Rodgers 1974, 1975).

Although recent declines of great egret populations in the central coastal region of Texas occurred simultaneously with declines in coastal marine and estuarine fish populations (Chapman 1980), no causal relationship has been proven. At present there are no known management practices that provide suitable food alternatives for piscivorous species, such as the great egret, during periods of fish population decline. Known fish nursery and feeding areas need protection from destruction or habitat alteration to ensure adequate prey populations for fish-eating birds.

Cover

Nesting. The great egret is a versatile nester, using trees, shrubs, and ground sites in riparian forest, swamp, and island habitats. Most colony sites in Texas are on natural or dredged-material islands, but several inland sites are known (Chaney et al. 1978). Most colony sites in Louisiana are associated with coastal fresh- or brackish water marshland (Portnoy 1978). In some cases, great egrets successfully occupy artificial nesting structures (Wiese 1976). Few colony sites are known that lack a substantial water barrier. Most inland sites are in swamps where nest trees grow in water at least 0.6 m (2 ft) deep during the breeding season (Meanley 1955; Wiese 1976). Such colony isolation may be important to reduce predation (Taylor and Michael 1971) or other disturbance.

Nest height varies with vegetation height, and nests within a mixed-species heronry tend to be stratified vertically in an order that correlates with species body length (Burger 1978). Thus, great egret nests are usually higher than the nests of all other species except the great blue heron (Ardea herodia). Most great egret nests are situated near the top, but just below the crown, of vegetation (Meanly 1955; Teal 1965; Pratt 1972; Girard 1976; Wiese 1976; Maxwell and Kale 1977; Portnoy 1978; Thompson 1979; Beaver et al. 1980). Terres (1980) noted that nests were usually about 6.1-12.2 m (20-40 ft) above the ground in medium sized trees. In coastal shrub-scrub vegetation, mean nest heights of 2.8 m (9.2 ft) (Maxwell and Kale 1977) and 1.7 m (5.6 ft) (Beaver et al.) have been reported. McCrimmon (1978) identified several additional characteristics of great egret nest placement that differ from other species: great egrets nested in larger trees, closer to the edge of the heronry, and in more open and accessible sites. Trees and shrub species where great egrets in coastal Texas and Louisiana build nests are listed in Table 1.

Because great egret nests are large (0.6 m or 2 ft) in diameter (Girard 1976), they are usually supported by several limbs that have a combined mean diameter of 5.9 cm (2.3 inches) (McCrimmon 1978). Thus, suitable nest site criteria may be related not only to available space, but also to minimum nest support. If vegetation for suitable nest support is present, great egrets can nest close to each other. Nearest nest distances of 1 m (3.3 ft) have been found in densely packed colonies (Beaver et al. 1980).

Table 1. Scientific name, common name, and mean vegetation height of all plants reported as nest species for great egrets in Texas and Louisiana.

Scientific name	Common name	Mean height (m)	Reference
Acacia farnesiana	Huisache	1	Goering and Cherry 1971
Acer rubrum	Red maple	1	Taylor and Michael 1971
Avicennia germinans	Black mangrove	1	Chaney et al. 1978
Baccharis halifolia	Sea myrtle	1	Burger 1978 Chaney et al. 1978
Celtis lindheimeri	Hackberry	5	Chaney et al. 1978
Cephalanthus occidentalis	Buttonbush	7	Taylor and Michael 1971
Iva frutescens	Marsh-elder	1	Chaney et al. 1978 Portnoy 1977
Nyssa sp.	Tupelo	7	Portnoy 1977
Opuntia lindheimeri	Prickly-pear	1	Chaney et al. 1978
Prosopis glandulosa	Mesquite	2	Chaney et al. 1978
Salix nigra	Black willow	5	Wiese 1976
Sambucus canadensis	Common elder-berry	1	Chaney et al. 1978
Scirpus spp.	Bulrush	1	Oberholser and Kincaid 1974
Spartina patens	Marshhay cordgrass	1	Chaney et al. 1978
Tamarix sp.	Salt cedar	2	Burger 1978
Taxodium sp.	Cypress	8	Simmons 1959
Zanthoxylum clava-herculis	Tickle-tongue	5	Chaney et al. 1978

Although great egrets usually nest in the crowns of trees and shrubs, ground nests have been reported in Texas (Chaney et al. 1978) and elsewhere (McCrimmon 1978). Ground nests are rare and usually found adjacent to a heronry on an island; apparently, ground nesting occurs when there is a lack of suitable nest sites in trees or shrubs in or near a dense colony.

Colony size of single-species or mixed-species heronries varies from four nests in a single tree or shrub to several thousand nests scattered throughout a heterogeneous vegetative association covering 6 ha (15 acres) or more (Portnoy 1977; Chaney et al. 1978; Nesbitt et al. 1982). Great egret nests tend to be clumped within a mixed-species heronry because their nest placement requirements differ from other herons.

There is evidence that herons re-use colony sites (Custer and Osborn 1977). Repeated use of a site may depend upon several factors: (1) prior (successful) experience at a site (Wiese 1978b); (2) the presence of other herons, particularly the great blue heron, which begins nesting before the great egret (Chaney et al. 1978); and (3) the remnants of old nests (Wiese 1976). Colony abandonment can result from the destruction of nest vegetation (Wiese 1979) or from changes in feeding habitat (Custer et al. 1980). Human disturbance and predation have also been implicated as factors contributing to colony abandonment (Chaney et al. 1978).

Non-nesting. Great egrets roost nocturnally in communal sites when not breeding. These sites are usually at the tops of tall trees in dense thickets or in the tops of short trees on islands or over water (Bent 1926). Roosting sites may be used for many years, and some may also be used for nesting. The characteristics of roost sites are similar to the those of nest sites, but no specific data have been published.

Water

The physiologic water requirement of great egrets is probably met during feeding activities in aquatic habitats (Dusi et al. 1971). Water depth affects the quantity, variety, and distribution of food and cover; great egret food and cover needs are generally met between the shoreline and water 0.5 m (1.6 ft) deep (Willard 1977).

Interspersion

Suitable habitat for the great egret must include (1) extensive shallow, open water habitat from 10 to 23 cm (4 to 9 inches) deep (Willard 1977); (2) food species present in sufficient quantity (Custer and Osborn 1977); and (3) adequate nesting or roosting habitat close to feeding habitat. Most great egrets at a colony in North Carolina flew less than 4 km (2.5 mi) from nesting colonies (and presumably, from roosting sites) to feeding areas (Custer and Osborn 1978a), but flight distances of up to 36 km (22.4 mi) have been recorded in the floodplain of the Upper Mississippi River (Thompson 1979b).

Several heronries may be close together. Great egrets from one colony may fly over or near an adjacent colony, but rarely feed in the same areas as conspecifics from the adjacent colony (Thompson 1979b).

Special Considerations

Human disturbance and habitat alteration are the two factors considered most responsible for the decline of the great egret throughout its range (Custer and Osborn 1977; Portnoy 1977; Chaney et al. 1978; Chapman 1980). Great egrets are sensitive to human disturbance and may abandon nests or entire colonies as a result of human activity (Goering and Cherry 1971; Mendoza and Ortiz 1974). Human presence in a colony may cause nest desertion, which leads to high nestling mortality from exposure, predation, and accidents (Morrison and Shanley 1978).

Traditional colony sites and nocturnal roosts should be preserved. Secondary sites of similar ecologic constitution are also important. High heron density within a colony may destroy nest vegetation by the effects of guano buildup and, to a lesser extent, trampling (Wiese 1978a,b). When this type of habitat destruction occurs, great egrets may pioneer adjacent suitable sites.

HABITAT SUITABILITY INDEX (HSI) MODELS

Model Applicability

Geographic area. The habitat suitability index (HSI) models in this report were developed for application in coastal wetland habitats in Texas and Louisiana. Because there are few differences in habitat requirements along the Atlantic coast, the remainder of the gulf coast, and inland sites in the Southeastern United States, the HSI models may also be used to evaluate potential habitat in those areas.

Season. These models will produce HSI values based upon habitat requirements of great egrets during the breeding season (February to August). Because there is no apparent seasonal difference in feeding habitat preference and because winter nocturnal roosts are similar to nesting sites, the HSI models may also be used to evaluate winter habitat for the great egret.

Cover types. Great egrets nest on upland islands and in the following cover types of Cowardin et al. (1979): Estuarine Intertidal Scrub-Shrub wetland (E2SS), Estuarine Intertidal Forested wetland (E2FO), Palustrine Scrub-Shrub wetland (PSS) (including deciduous and evergreen subclasses), and Palustrine Forested wetland (PFO) (including deciduous and evergreen subclasses). Great egrets may also feed in these wooded wetlands, but preferred feeding areas may be any one of a wide variety of wetland cover types (Table 2).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous suitable habitat required before an area can be occupied by a particular species. Specific information on minimum areas required by great egrets was not found in the literature. If local information is available to define the minimum habitat area, and less than this amount of area is available, the HSI for the species will be zero.

Verification level. The output of these HSI models is an index between 0 and 1.0 that is believed to reflect habitat potential for great egrets. Two biologists reviewed and evaluated the great egret HSI model throughout its development: Dr. R. Douglas Slack, Texas A&M University, College Station, and Jochen H. Wiese, Environmental Science and Engineering Company, Gainesville, Florida. Their recommendations were incorporated into the model-building effort. The authors, however, are responsible for the final version of the models. The models have not been field-tested.

Table 2. Great egret feeding habitat types. Classification follows Cowardin et al. (1979).

System	Subsystem	Class	Abbreviation
Estuarine	Intertidal	Aquatic Bed	E2AB
		Emergent	E2EM
		Forested	E2FO
		Stream Bed	E2SB
		Scrub-Shrub	E2SS
		Unconsolidated Shore	E2US
Riverine	Tidal	Aquatic Bed	R1AB
		Emergent	R1EM
		Unconsolidated Bottom	R1UB
		Unconsolidated Shore	R1US
	Lower Perennial	Aquatic Bed	R2AB
		Emergent	R2EM
		Unconsolidated Bottom	R2UB
		Unconsolidated Shore	R2US
	Intermittent	Stream Bed	R4SB
Lacustrine	Littoral	Aquatic Bed	L2AB
		Emergent	L2EM
		Unconsolidated Bottom	L2UB
		Unconsolidated Shore	L2US
Palustrine		Aquatic Bed	PAB
		Forested	PFO
		Emergent	PEM
		Scrub-Shrub	PSS
		Unconsolidated Bottom	PUB
		Unconsolidated Shore	PUS

Model Descriptions

Overview. Separate HSI models were developed to evaluate great egret feeding and nesting habitats. No attempt was made to integrate these two models into a single, overall habitat model for the following reasons. As noted previously, most great egrets fly less than 4 km (2.5 mi) from nesting or roosting sites to feeding areas, but they may travel up to 36 km (22.4 mi). HSI models are intended primarily for use in impact assessment and may be applied in relatively small study areas. The study area for great egret may or may not contain both feeding and nesting cover types, and great egrets may use habitat outside the study area boundaries. An HSI model integrating food and nesting requirements may assign a low or no value to an area with cover types that supply only one of these requirements when the remaining requirement is met outside the area. Similarly, a single HSI model would downgrade the value of an area that had high-quality nesting habitat and where birds were bypassing low-quality feeding sites to use higher quality feeding sites outside the area. Separate models that evaluate potential feeding or potential nesting habitat quality avoid problems of the type outlined above and retain simplicity in model application. The relationships of habitat variables to the feeding and nesting HSI values are illustrated in Figure 1.

Feeding HSI model. Great egret feeding habitat suitability is related to prey availability. Habitat suitability is optimal when two conditions are met: (1) the populations of minnow-sized fish are high; and (2) shallow open water (necessary for successful prey capture), aquatic vegetation (necessary for prey survival and reproduction), and deeper water are present in a ratio that maximizes prey density and minimizes hunting interference. Use of this model assumes that deep or permanent water environments are not limiting in coastal habitats and that fish populations are distributed uniformly. Because great egrets hunt a variety of species in many different habitat types, a general approach to modeling feeding habitat suitability is presented. Suitability of all wetland cover types for feeding is determined by integrating two factors: (1) the abundance of prey and (2) the accessibility of prey.

The abundance of prey is determined by the ability of the habitat to support the major prey species, especially minnow-sized fish. It is assumed that the abundance of major prey species is related to the primary and secondary productivity of the aquatic habitat; however, few field studies have documented this relationship. The model assumes that prey abundance is not limiting in coastal habitats. Therefore, the accessibility of prey is used as the indicator of feeding habitat suitability.

The accessibility of prey is determined by water depth and percentage cover of aquatic vegetation. A wetland with 100% of its area covered by water 10-23 cm (4-9 inches) deep is assumed to be optimal for feeding by great egrets (V_1). Although an absence of submerged or emergent vegetation would render fish species most vulnerable to capture, it is unlikely that many prey species would use such an area because it totally lacks cover. The model assumes, therefore, that optimal conditions for both the occurrence and susceptibility to capture of prey species exist when 40%-60% of the wetland substrate is covered by submerged or emergent vegetation (V_2). When such vegetation is

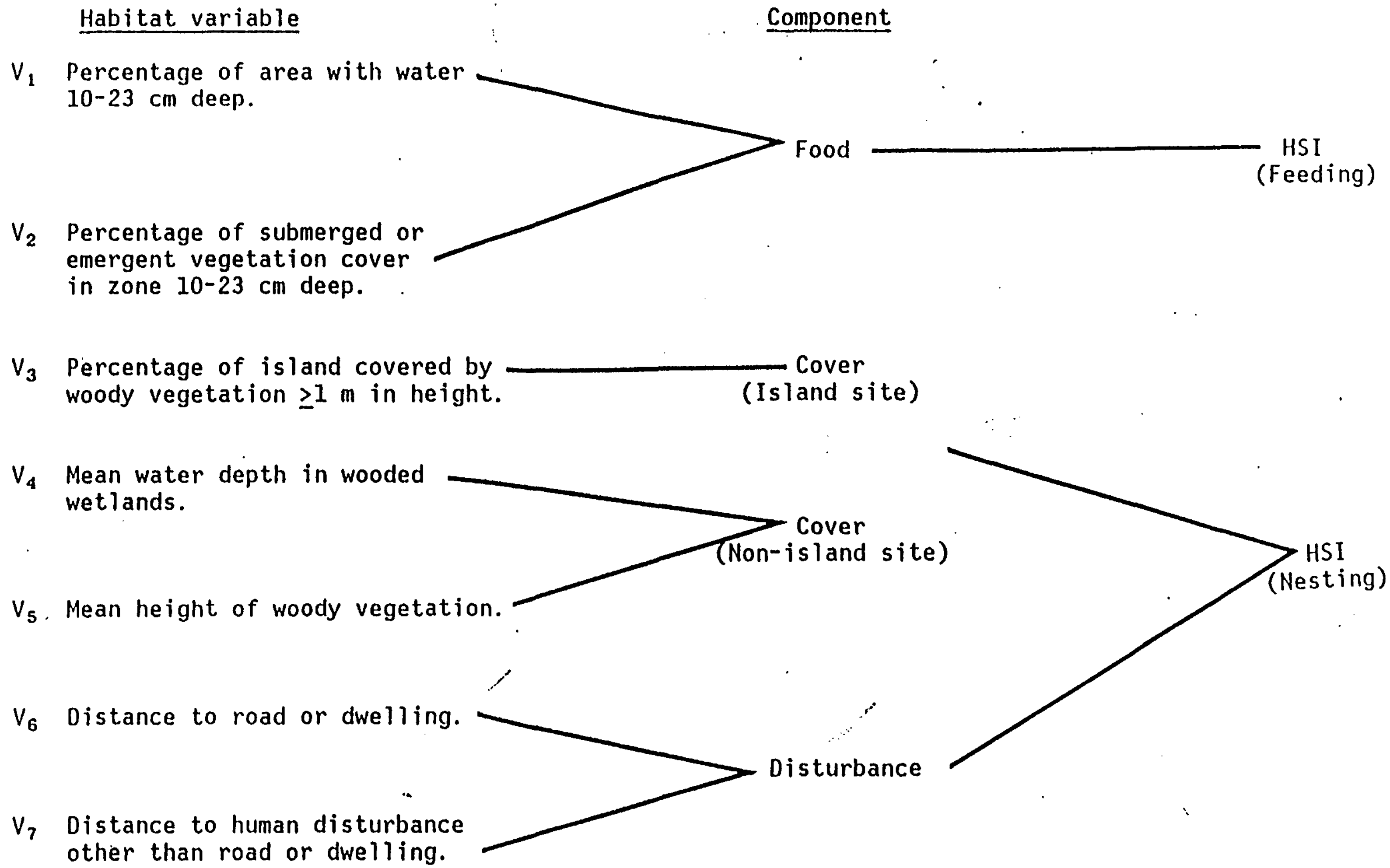


Figure 1. Relationships of habitat variables and components to the separate HSI models for great egret feeding and nesting habitats.

lacking, the habitat has a low value for feeding great egrets because small fish may use unvegetated water that is too shallow for their larger aquatic predators.

Nesting HSI model. The suitability of potential nesting sites for great egrets is determined by two factors: cover and disturbance (Figure 1). In this model, ground nesting is not considered because it involves few individuals, occurs in proximity to "normal" colonies, and may reflect a response to overcrowding rather than site preference.

Cover for nesting great egrets depends on vegetation characteristics and the presence of water barriers. On islands surrounded by deep or wide water barriers, great egrets nest in a wide variety of habitats ranging from low (1 m, or 3.3. ft) shrubs or grasses with dense canopies, to tall trees. Therefore, cover suitability of nesting habitat on islands is assumed to be related to the percentage of the island area having woody vegetation equal to or exceeding 1 m (3.3 ft) in height (V_3). Optimal habitat is present when 60% or more of the island supports woody vegetation equal to or exceeding 1 m in height. For the application of this model, islands are defined as sites less than 5 ha (12.4 acres) and completely surrounded by open water. Islands can be either along the coast or located inland in freshwater habitats.

In any given area, some or all of the great egret population may nest in non-island sites even though island habitats with suitable cover types are available. Non-island nest sites are found in shrubs or trees in seasonally (during the great egret nesting season) or permanently flooded areas such as the Estuarine Intertidal and Palustrine Scrub-Shrub and Forested wetlands (Cowardin et al. 1979). For such areas, the model assumes that nesting suitability varies with water depth (V_4) and that a water depth of 0.6 m (2 ft) or more reduces access by potential predators and represents optimal conditions for nesting. The mean height of woody vegetation in non-island sites must exceed 7 m (23 ft) to be optimal for nesting by great egrets (V_5).

Great egrets are sensitive to disturbance from humans and predators, especially during the breeding season. Boating and other water activities do not disturb nesting great egrets if they occur 50 m (164 ft) or more from the colony, the noise level is normal (no horns or other loud noises), and no humans walk in or near the colony. No colonies are known to occur within 0.5 km (0.3 mi) of a roadway or human dwelling. The model assumes that as the distance from human disturbance increases, the suitability of a site also increases. Sites 0.5 km (0.3 mi) or closer to a roadway or dwelling (V_6) are unsuitable for nesting by great egrets. Optimal sites must be at least 50 m (164 ft) from a channel or other potential source of human disturbance (V_7).

Suitability Index (SI) Graphs for Model Variables

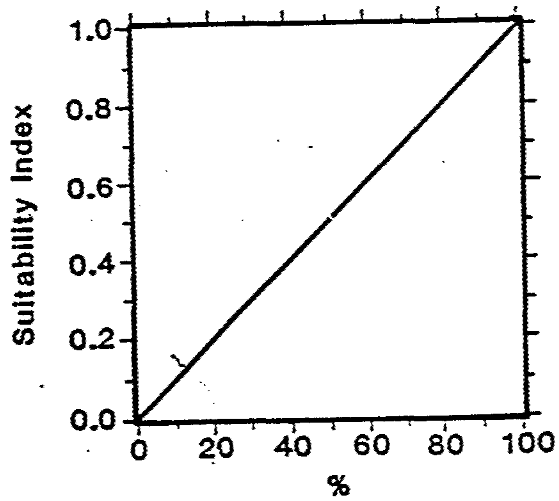
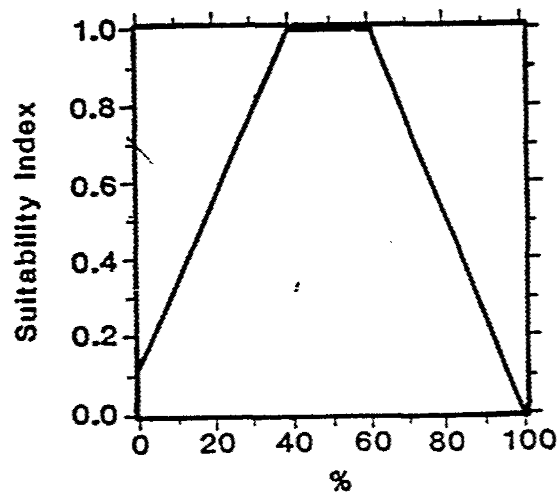
This section provides graphic representation of the relationship between habitat variables and habitat suitability for the great egret in wetland (see Table 2 for abbreviations) and upland (U) cover types. The SI values are read directly from the graph (1.0 = optimal suitability, 0.0 = no suitability) for each variable. Assumptions used in developing the SI graph for each variable appear in Table 3.

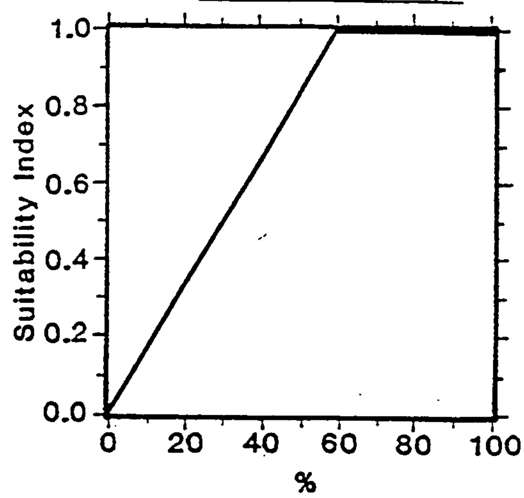
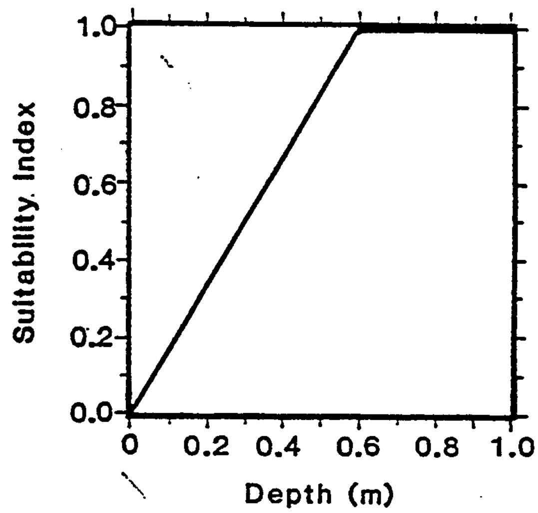
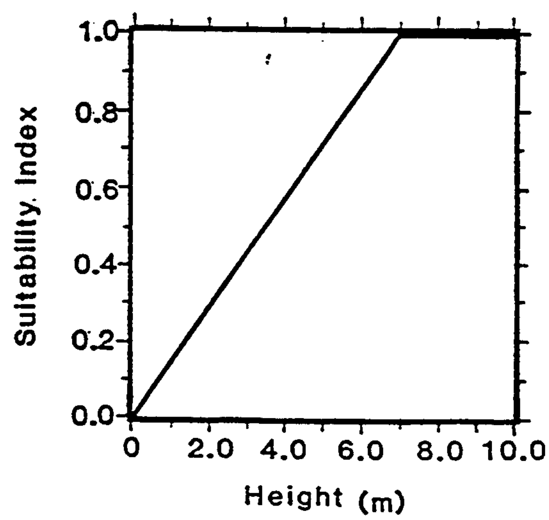
Table 3. Data sources and assumptions for great egret suitability indices.

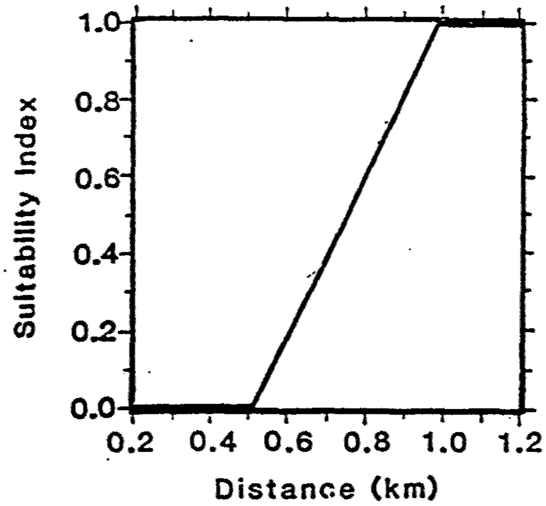
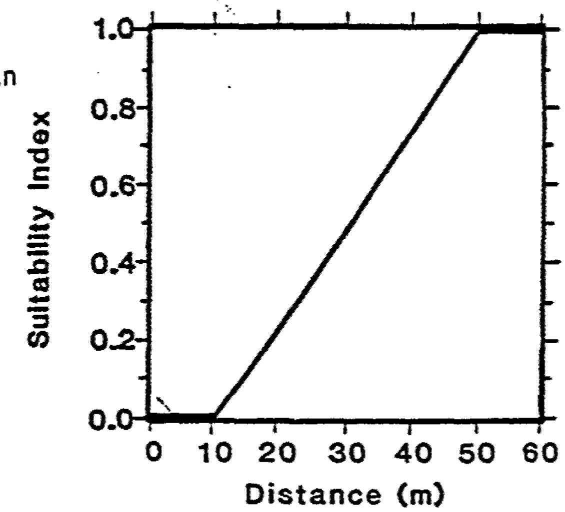
Variable and source	Assumption
V_1 Willard 1977	Prey is most accessible in water depths of 10-23 cm (4-9 inches).
V_2 Willard 1977	Substrates with 40%-60% coverage of emergent or submerged vegetation provide the optimum balance between cover for prey species and vulnerability of prey to capture by great egrets.
V_3 Chaney et al. 1978 Portnoy 1978	Suitability of nesting/roosting habitat on islands is positively related to the percentage canopy cover of woody vegetation $\geq$ 1 m (3.3 ft) tall.
V_4 Meanley 1955 Wiese 1976	Optimal nesting habitat for non-island sites is found when mean water depth beneath the woody vegetation is equal to or deeper than 0.6 m (2 ft).
V_5 Pratt 1972 McCrimmon 1978 Wiese 1978b Beaver et al. 1980	Suitability of nesting/roosting habitat on non-island sites increases with vegetation canopy height; optimum mean height equals or exceeds 7 m (23 ft).
V_6 (a)	Human disturbance is detrimental to great egret nesting/roosting. Optimal habitat occurs where the nearest road or dwelling is 0.5 km (0.3 mile) or farther from the site.
V_7 (a)	The optimal distance from potential nesting/roosting sites to disturbance other than roads or dwellings exceeds 50 m.

[a]These variables are not discussed in the literature on the great egret; they were derived from general discussions in Thompson (1979) and Rodgers and Burger (1982), from personal observations, and from results of other colonial seabird studies.

The SI graphs are based on the assumption that the suitability of a particular variable can be represented by a two-dimensional linear response surface. Although there may be interdependencies and correlations between many habitat variables, the model assumes that each variable operates independently over the range of other variables under consideration. Habitat abbreviations are defined in Table 2.

Habitat	Variable		Suitability Graph
All habitats in Table 2.	V_1	Percentage of study area with water 10-23 cm deep. In tidal areas, use depth at mean low tide. In nontidal areas, use average summer conditions.	
All habitats in Table 2.	V_2	Percentage of substrate in zone 10-23 cm deep covered by submerged or emergent vegetation.	

Habitat	Variable		Suitability Graph
E2SS,E2FO,U	V_3	Percentage of island covered by woody vegetation $\geq$ 1 m in height.	
E2SS, E2FO, PSS, PFO	V_4	Mean water depth in wooded wetlands.	
E2SS, E2FO, PSS, PFO	V_5	Mean height of woody vegetation.	

Habitat	Variable		Suitability Graph
E2SS, E2FO, PSS, PFO, U	V_6	Distance to road or dwelling.	
E2SS,E2FO, PSS, PFO, U	V_7	Distance to human disturbance other than road or dwelling.	

Component Index Equations and HSI Determination

The following equations are suggested for combining individual variable SI values into component indices and for obtaining the final HSI value. The HSI for feeding (or nesting) habitat is set at 0 if no cover type suitable for nesting (or feeding) can be located within 36 km (22.4 mi) of the study area.

Feeding HSI.

Component	Equation
Food (F)	$\frac{SI_{V_1} + SI_{V_2}}{2}$

$$HSI = F$$

Nesting HSI

Component	Equation
Cover, islands (C_i)	SI_{V_3}
Cover, non-islands (C_n)	$(SI_{V_4} \times SI_{V_5})^{1/2}$
Disturbance (D)	$(SI_{V_6} \times SI_{V_7})^{1/2}$

HSI (Islands) = C_i or D, whichever is lower.

HSI (Non-islands) = C_n or D, whichever is lower.

Data representing three hypothetical study areas for great egret were used to calculate sample HSI values (Table 4). The HSI values obtained are believed to reflect the potential of the areas to support feeding or nesting great egrets.

Field Use of Models

The level of detail needed for application of these models will depend on time, money, and accuracy constraints. Detailed field sampling of all variables will provide the most reliable and replicable HSI values. Any or all variables can be estimated to reduce the amount of time or money required to apply the models. Increased use of the subjective estimates decreases reliability and replicability, and these estimates should be accompanied by appropriate documentation to insure that decisionmakers understand both the method of HSI determination and quality of data used in the model. Techniques for measuring habitat variables included in the great egret HSI models are suggested in Table 5.

A project area may contain both potential feeding and nesting habitat. To decrease the cost and time necessary to evaluate the area, assume that food is not limiting and apply only the nesting HSI model. This recommendation is based upon the following assumptions: (1) in most coastal areas of Texas and Louisiana, aquatic habitats suitable for feeding are abundant and are, therefore, less of a limiting factor to great egrets than are suitable nesting sites; and (2) nesting value is easier and more accurately estimated by using subjective methods than is food value. The variables used to measure food

Table 4. Calculations of suitability indices (SI), component indices, and habitat suitability indices (HSI) for three sample data sets using habitat variable (V) measurements and the great egret HSI model equations.

Model element	Data set 1 Data	Data set 1 SI	Data set 2 Data	Data set 2 SI	Data set 3 Data	Data set 3 SI
Variables						
V_1	60%	0.60	-	-	-	-
V_2	90%	0.25	-	-	-	-
V_3	-	-	75%	1.0	-	-
V_4	-	-	-	-	0.27 m	0.45
V_5	-	-	-	-	6 m	0.86
V_6	-	-	1.0 km	1.0	0.75 km	0.5
V_7	-	-	25 m	0.38	50 m	1.0
Component indices						
F	0.43		-		-	
C_i	-		1.0		-	
C_n	-		-		0.62	
D	-		0.61		0.71	
HSI						
Feeding	0.43		-		-	
Nesting	-		0.61		0.62	

value are more indirect than those used to measure nesting value. This reflects the difficulties involved with measuring prey abundance, prey distribution, and prey accessibility.

A major assumption of the nesting HSI model is that all habitat areas with appropriate cover types have some potential value to great egrets. However, it is difficult to assess this potential because of two factors: (1) traditional

use of past colony sites, and (2) the enhancement of a site by the presence of other herons. These two factors are usually, but not always, interrelated. Great egrets tend to use the same colony site in successive years until the site is degraded, and the site may include great blue herons. When applying the HSI model, the user should be aware that an area known to be used by great egrets (or great blue herons) is more likely to be used in future years than an area with an equal HSI value not known to have a history as a colony site.

Table 5. Suggested measurement techniques for habitat variables used in the great egret HSI models.

Variable	Suggested technique
V_1	The percentage of the area with water 10-23 cm (4-9 inches) deep can be determined by line transect sampling of water depth.
V_2	The percentage of substrate in the 10-23 cm (4-9 inches) water depth zone covered by submerged or emergent vegetation can be determined from available cover maps, aerial photographs, or by line transect sampling.
V_3	The percentage of an island covered by woody vegetation $\geq$ 1 m (3.3 ft) in height can be determined by measuring the height of randomly selected vegetation with a hypsometer or altimeter (Hays et al. 1981).
V_4	Mean water depth beneath woody vegetation on non-island sites can be determined by line transect sampling of water depth.
V_5	Mean height of woody vegetation on non-island sites can be measured by using a hypsometer or altimeter (Hays et al. 1981) on randomly selected vegetation.
V_6,V_7	Distance to disturbance can be measured on maps or aerial photographs. The disturbance location should be marked and the straight line distance measured from the disturbance to the middle of the potential nest/roost site.

If two or more distinct units of either potential feeding or nesting habitat are present within the project evaluation area, a single feeding or nesting index value for the project may be obtained by weighting the HSI of each unit by its area. When a weighted HSI is desired, the following equation should be applied:

$$HSI = \frac{\sum_{i=1}^{n} HSI_i A_i}{\sum A_i}$$

where n=number of distinct units of habitat
HSI_i=HSI of unit_i
A_i=area of unit_i

Interpreting Model Output

The HSI value obtained by applying the great egret models may have no relationship to actual population levels. Great egret population levels may be determined by nonhabitat factors, such as competition and predation, excluded from the models. Model outputs can be used, however, to compare the potential of two areas to support feeding or nesting great egrets at a single point in time. HSI values can also be used to compare the potential of a single area to support great egrets at future points in time.

ADDITIONAL HABITAT MODELS

No other habitat model for the great egret was located.

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APPENDIX F-4

HEP ANALYSIS - FORMS B, D, AND H

EMERGENT MARSH - SITE 3

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.32	0.02

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.32	0.02

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.32	0.02

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.32	0.02

Form B: Habitat Units — Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 1 (without project) — WITHOUT THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.32	0.02

Form B: Habitat Units — Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 2 (with project) — WITH THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.32	0.0[illegible]

Form B: Habitat Units — Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 2 (with project) — WITH THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.00	0.[illegible]

Form B: Habitat Units — Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 2 (with project) — WITH THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.27	0.01

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 3

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.32	0.02

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.05	0.32	0.02

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	5.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	5.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	5.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
	GREAT EGRET	5.00	0.00	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	5.00	0.00	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	5.00	0.00	0.00

Form D: Net Change in AAHU's Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	GREAT EGRET	0.02	0.02	-0.00

Form D: Net Change in AAHU's Date: 01/13/1995

Study Name: EMERGENT MARSH, SITE 3
Action: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	GREAT EGRET	4.33	0.00	4.33

Area Needed For In-Kind Compensation Date: 01/13/1995
(Form H Results)

Study Name: EMERGENT MARSH, SITE 3
Plan Alternative: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Management Plan: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Candidate Management Area Size: 5.00

		Net Change In AAHU's		
Evaluation Species ID#	Name	Plan Alternative	Management Plan	Area Needed For Compensation
1	GREAT EGRET	-0.00	4.33	0.00

EMERGENT MARSH - SITES 5, 19

Form B: Habitat Units — Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 1 (without project) — WITHOUT THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.[illegible]

Form B: Habitat Units — Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 1 (without project) — WITHOUT THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.

Form B: Habitat Units — Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 1 (without project) — WITHOUT THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.0

Form B: Habitat Units — Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 1 (without project) — WITHOUT THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.0C

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.C

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	0.87	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	0.00	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	0.00	0.[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	0.00	0.00

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	0.50	1.5(

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 10

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	1.00	3.[illegible]

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	1.00	3.[illegible]

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	3.00	0.75	2.[illegible]

Form D: Net Change in AAHU's Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	GREAT EGRET	0.00	0.00	0.00

Form D: Net Change in AAHU's Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Action: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	GREAT EGRET	2.60	0.00	2.60

Area Needed For In-Kind Compensation
(Form H Results)
Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 5 & 19
Plan Alternative: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Management Plan: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Candidate Management Area Size: 3.00

Net Change In AAHU's

Evaluation Species ID#	Name	Plan Alternative	Management Plan	Area Needed Fo Compensation
1	GREAT EGRET	0.00	2.60	0.00

EMERGENT MARSH - SITES 12, 13, 15A

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12, 13, 15A
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.50	6.0

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12, 13, 15A
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.50	6.08

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12, 13, 15A
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.50	6.[illegible]

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12, 13, 15A
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.50	6.[illegible]

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12, 13, 15 A
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.50	6.08

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15 A
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.50	6.08

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15 A
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.00	0.00

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15 A
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.25	3.0·

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15A
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 3

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.50	6.08

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15A
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	12.16	0.50	6.0

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15A
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	0.00	0.

Form B: Habitat Units

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15 A
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	0.00	0.

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13 15A
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15A
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	0.00	0.0(

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15A
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	0.00	0.0(

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15A
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	0.00	0.(

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15 A
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	0.50	13.50

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13 15 A
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 10

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	1.00	27.0

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13 15 A
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	1.00	27.00

Form B: Habitat Units Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13, 15A
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	GREAT EGRET	27.00	0.75	20.25

Form D: Net Change in AAHU's

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13,15A
Action: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	GREAT EGRET	5.90	6.08	-0.18

Form D: Net Change in AAHU's

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13,15A
Action: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	GREAT EGRET	23.37	0.00	23.37

Area Needed For In-Kind Compensation
(Form H Results)

Date: 01/13/1995

Study Name: EMERGENT MARSH, SITES 12,13,15A
Plan Alternative: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Management Plan: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Candidate Management Area Size: 27.00

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Net Change In AAHU's: Management Plan	Area Needed For Compensation
1	GREAT EGRET	-0.18	23.37	0.20

RIPARIAN WOODLAND - SITE 12

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 1 (without project)　　WITHOUT THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.87	4.9[illegible]
2	NORTHERN ORIOLE	5.69	0.68	3.87

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 1 (without project)　　WITHOUT THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.87	4.9[illegible]
2	NORTHERN ORIOLE	5.69	0.66	3.7[illegible]

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 1 (without project)　　WITHOUT THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.89	5.[illegible]
2	NORTHERN ORIOLE	5.69	0.65	3.7[illegible]

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 1 (without project)　　WITHOUT THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.85	4.[illegible]
2	NORTHERN ORIOLE	5.69	0.64	3.[illegible]

Form B: Habitat Units — Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.77	4.38
2	NORTHERN ORIOLE	5.69	0.64	3.64

Form B: Habitat Units — Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.87	4.95
2	NORTHERN ORIOLE	5.69	0.68	3.87

Form B: Habitat Units — Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.00	0.00
2	NORTHERN ORIOLE	5.69	0.00	0.00

Form B: Habitat Units — Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.00	0.0
2	NORTHERN ORIOLE	5.69	0.00	0.0

Form B: Habitat Units

Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.00	0.(
2	NORTHERN ORIOLE	5.69	0.00	0.0

Form B: Habitat Units

Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	5.69	0.00	0
2	NORTHERN ORIOLE	5.69	0.00	0

Form B: Habitat Units

Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.00	0.
2	NORTHERN ORIOLE	12.00	0.00	C

Form B: Habitat Units

Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.00	0
2	NORTHERN ORIOLE	12.00	0.00	C

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.00	0.00
2	NORTHERN ORIOLE	12.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.00	0.0
2	NORTHERN ORIOLE	12.00	0.00	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.00	0.
2	NORTHERN ORIOLE	12.00	0.00	0.

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.00	0.
2	NORTHERN ORIOLE	12.00	0.00	0.

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.09	1.[illegible]
2	NORTHERN ORIOLE	12.00	0.27	3.24

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 10

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.34	4.0[illegible]
2	NORTHERN ORIOLE	12.00	1.00	12.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.57	6.8
2	NORTHERN ORIOLE	12.00	1.00	12.

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	12.00	0.91	10.
2	NORTHERN ORIOLE	12.00	0.96	11.

Form D: Net Change in AAHU's — Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: PA 2 (with project) — WITH THE PROJECT
Compared To: PA 1 (without project) — WITHOUT THE PROJECT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	YELLOW WARBLER	0.05	4.74	-4.69
2	NORTHERN ORIOLE	0.04	3.66	-3.62

Form D: Net Change in AAHU's — Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Action: MP 2 (with project) — WITH MANAGEMENT
Compared To: MP 1 (without project) — WITHOUT MANAGEMENT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	YELLOW WARBLER	6.97	0.00	6.97
2	NORTHERN ORIOLE	10.89	0.00	10.89

Area Needed For In-Kind Compensation (Form H Results) — Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 12
Plan Alternative: PA 2 (with project) — WITH THE PROJECT
Compared To: PA 1 (without project) — WITHOUT THE PROJECT
Management Plan: MP 2 (with project) — WITH MANAGEMENT
Compared To: MP 1 (without project) — WITHOUT MANAGEMENT
Candidate Management Area Size: 12.00

Net Change In AAHU's

Evaluation Species ID#	Name	Plan Alternative	Management Plan	Area Needed Fc Compensation
1	YELLOW WARBLER	-4.69	6.97	8.08
2	NORTHERN ORIOLE	-3.62	10.89	3.99

RIPARIAN WOODLAND - SITE 17

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.58	0.39
2	NORTHERN ORIOLE	0.68	0.74	0.50

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.82	0.5[illegible]
2	NORTHERN ORIOLE	0.68	0.73	0.5[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.84	0.57
2	NORTHERN ORIOLE	0.68	0.72	0.49

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.85	0.[illegible]
2	NORTHERN ORIOLE	0.68	0.72	0.4[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.82	0.56
2	NORTHERN ORIOLE	0.68	0.72	0.49

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.58	0.39
2	NORTHERN ORIOLE	0.68	0.74	0.50

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.00	0.00
2	NORTHERN ORIOLE	0.68	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.00	0.0
2	NORTHERN ORIOLE	0.68	0.00	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.00	0.[illegible]
2	NORTHERN ORIOLE	0.68	0.00	0.[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	0.68	0.00	0.00
[illegible]	NORTHERN ORIOLE	0.68	0.00	0.[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.00	0.[illegible]
2	NORTHERN ORIOLE	2.00	0.00	0.0[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.00	0.[illegible]
2	NORTHERN ORIOLE	2.00	0.00	0.[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.00	0.00
2	NORTHERN ORIOLE	2.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.00	0.00
2	NORTHERN ORIOLE	2.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.00	0.00
2	NORTHERN ORIOLE	2.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.00	0.00
2	NORTHERN ORIOLE	2.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 1

Evaluation Species ID#	Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.09	0.18
2	NORTHERN ORIOLE	2.00	0.27	0.54

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 10

Evaluation Species ID#	Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.34	0.68
2	NORTHERN ORIOLE	2.00	1.00	2.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 20

Evaluation Species ID#	Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.57	1.14
2	NORTHERN ORIOLE	2.00	1.00	2.0

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 52

Evaluation Species ID#	Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	2.00	0.91	1.82
2	NORTHERN ORIOLE	2.00	0.96	1.92

Form D: Net Change in AAHU's Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	YELLOW WARBLER	0.00	0.57	-0.56
2	NORTHERN ORIOLE	0.00	0.49	-0.49

Form D: Net Change in AAHU's Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	YELLOW WARBLER	1.16	0.00	1.16
2	NORTHERN ORIOLE	1.82	0.00	1.82

Area Needed For In-Kind Compensation Date: 01/13/1995
(Form H Results)

Study Name: RIPARIAN WOODLAND, SITE 17
Plan Alternative: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Management Plan: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Candidate Management Area Size: 2.00

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Management Plan	Area Needed For Compensation
1	YELLOW WARBLER	-0.56	1.16	0.97
2	NORTHERN ORIOLE	-0.49	1.82	0.53

RIPARIAN WOODLAND - SITE 18

Form B: Habitat Units   Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.67	1.2
2	NORTHERN ORIOLE	1.87	0.58	1.0

Form B: Habitat Units   Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.84	1.[illegible]
2	NORTHERN ORIOLE	1.87	0.63	1.10

Form B: Habitat Units   Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.87	1.[illegible]
2	NORTHERN ORIOLE	1.87	0.68	1.2

Form B: Habitat Units   Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.85	1.3
2	NORTHERN ORIOLE	1.87	0.77	1.4

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.82	1.53
2	NORTHERN ORIOLE	1.87	0.75	1.40

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.67	1.25
2	NORTHERN ORIOLE	1.87	0.58	1.08

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.00	0.00
2	NORTHERN ORIOLE	1.87	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.00	0.00
2	NORTHERN ORIOLE	1.87	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.00	0.00
2	NORTHERN ORIOLE	1.87	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	1.87	0.00	0.0(
2	NORTHERN ORIOLE	1.87	0.00	0.0(

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.00	0.00
2	NORTHERN ORIOLE	4.00	0.00	0.0C

Form B: Habitat Units Date: 01/13/1995

St y Name: RIPARIAN WOODLAND, SITE 18
Act on: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.00	0.00
2	NORTHERN ORIOLE	4.00	0.00	0.0^

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.00	0.00
2	NORTHERN ORIOLE	4.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.00	0.00
2	NORTHERN ORIOLE	4.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.00	0.00
2	NORTHERN ORIOLE	4.00	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.00	0.0
2	NORTHERN ORIOLE	4.00	0.00	0.0

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.09	0.3
2	NORTHERN ORIOLE	4.00	0.27	1.08

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 10

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.34	1.3[illegible]
2	NORTHERN ORIOLE	4.00	1.00	4.[illegible]

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.57	2.[illegible]
2	NORTHERN ORIOLE	4.00	1.00	4.0[illegible]

Form B: Habitat Units　　　　Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	4.00	0.91	3.
2	NORTHERN ORIOLE	4.00	0.96	3.[illegible]

Form D: Net Change in AAHU's

Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	YELLOW WARBLER	0.01	1.58	-1.56
2	NORTHERN ORIOLE	0.01	1.39	-1.38

Form D: Net Change in AAHU's

Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Action: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	YELLOW WARBLER	2.32	0.00	2.32
2	NORTHERN ORIOLE	3.63	0.00	3.63

Area Needed For In-Kind Compensation
(Form H Results)

Date: 01/13/1995

Study Name: RIPARIAN WOODLAND, SITE 18
Plan Alternative: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Management Plan: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Candidate Management Area Size: 4.00

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Net Change In AAHU's: Management Plan	Area Needed For Compensation
1	YELLOW WARBLER	-1.56	2.32	2.69
2	NORTHERN ORIOLE	-1.38	3.63	1.52

SCRUB-SCRUB - SITE 20

Form B: Habitat Units Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.48	1.5[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.70	2.[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.84	2.[illegible]

Form B: Habitat Units Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.85	2.7[illegible]

Form B: Habitat Units | Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.82	2.64

Form B: Habitat Units | Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.48	1.55

Form B: Habitat Units | Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.00	0.0

Form B: Habitat Units | Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.00	0.0(

Form B: Habitat Units Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	3.22	0.00	0.00

Form B: Habitat Units Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.00	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.00	0.0

Form B: Habitat Units

Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.00	0.00

Form B: Habitat Units

Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.00	0.00

Form B: Habitat Units

Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.00	0.00

Form B: Habitat Units

Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.00	0.00

Form B: Habitat Units | Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.09	0.54

Form B: Habitat Units | Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 10

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.34	2.0[illegible]

Form B: Habitat Units | Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.57	3.4

Form B: Habitat Units | Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 52

ation #	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	YELLOW WARBLER	6.00	0.91	5.4

Form D: Net Change in AAHU's

Study Name: SCRUB-SHRUB, SITE 20
Action: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	YELLOW WARBLER	0.01	2.68	-2.67

Form D: Net Change in AAHU's Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Action: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	YELLOW WARBLER	3.49	0.00	3.49

Area Needed For In-Kind Compensation (Form H Results) Date: 01/13/1995

Study Name: SCRUB-SHRUB, SITE 20
Plan Alternative: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Management Plan: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Candidate Management Area Size: 6.00

Evaluation Species ID#	Name	Net Change In AAHU's Plan Alternative	Net Change In AAHU's Management Plan	Area Needed Fo Compensation
1	YELLOW WARBLER	-2.67	3.49	4.59

PERMANENT WETLAND - SITE 17

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.70	0.

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.70	0..

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.70	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habita Units
1	MALLARD	0.05	0.50	0

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 1 (without project) WITHOUT THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.40	0.02

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.25	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.25	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.25	0.0

Form B: Habitat Units

Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.25	0.01

Form B: Habitat Units

Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.05	0.25	0.01

Form B: Habitat Units

Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.00	0.0

Form B: Habitat Units

Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.00	0.0

Form B: Habitat Units

Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 2

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.00	0.00

Form B: Habitat Units

Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.00	0.00

Form B: Habitat Units

Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 1 (without project) WITHOUT MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.00	0.00

Form B: Habitat Units

Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 0

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.00	0.0

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 1

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.35	0.1

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 10

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.95	0.4

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 20

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.95	0.4

Form B: Habitat Units Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Target Year: 52

Evaluation ID#	Species Name	Area of Habitat	Habitat Suitability Index	Habitat Units
1	MALLARD	0.50	0.95	0.

Form D: Net Change in AAHU's   Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	MALLARD	0.01	0.03	-0.01

Form D: Net Change in AAHU's   Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Action: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Period of analysis: 52

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	MALLARD	0.44	0.00	0.44

Area Needed For In-Kind Compensation
(Form H Results)   Date: 01/13/1995

Study Name: PERMANENT WETLAND, SITE 17
Plan Alternative: PA 2 (with project) WITH THE PROJECT
Compared To: PA 1 (without project) WITHOUT THE PROJECT
Management Plan: MP 2 (with project) WITH MANAGEMENT
Compared To: MP 1 (without project) WITHOUT MANAGEMENT
Candidate Management Area Size: 0.50

Evaluation Species ID#	Name	Net Change In AAHU's: Plan Alternative	Net Change In AAHU's: Management Plan	Area Needed For Compensation
1	MALLARD	-0.01	0.44	0.01

Appendix B

Biological Data Report

May 24, 1995

Environmental Resources Branch

Mr. Joel A. Medlin, Field Supervisor
Fish and Wildlife Enhancement
Fish and Wildlife Service
2800 Cottage Way, Room E-1803
Sacramento, California 95825

Dear Mr. Medlin:

This is our biological assessment for the Sacramento Flood Control Project System Evaluation, Phase III, Mid-Valley Area. Enclosed is a biological data report which addresses any potential effects of the proposed project on species of concern within the project area. Federally listed species include winter-run chinook salmon, delta smelt, giant garter snake, bald eagle, American peregrine falcon, Aleutian Canada goose, vernal pool tadpole shrimp, valley elderberry longhorn beetle, vernal pool fairy shrimp, conservancy fairy shrimp, delta green ground beetle, palmate-bracted bird's-beak, and Solano grass. Proposed species include Sacramento splittail, California red-legged frog, Contra Costa goldfields, Colusa grass, and Hartweg's golden sunburst. In addition, there are a total of 23 species of concern (candidate and recommended for candidate) status described. All of these species were identified in your letter dated April 18, 1995 (Ref # 1-1-95-SP-647), as possibly occurring within the project area.

It is our biological assessment that the proposed project would not adversely affect the 13 listed and 5 proposed species except for the valley elderberry longhorn beetle and possibly the giant garter snake. Additional information on these species is summarized in the paragraphs that follow. We will coordinate/consult further with your office to confirm this finding. An environmental assessment has been prepared and coordinated to describe impacts to all significant resources for this phase of the project. If an adverse impact to any of the listed or proposed species becomes apparent during this process, we will then supplement this biological assessment with that new information. Also, if the status of any of the 16 candidate species not addressed changes to proposed during construction, additional assessments would be prepared.

The endangered winter-run chinook salmon does occur in the Sacramento River near the project area. However, construction activities will be confined to the crown and landside of levees, and measures will be taken to ensure that soils and construction materials do not enter the river. Therefore, it is our assessment that the winter-run chinook salmon will not

likely be affected by this project. In a June 22, 1994, telephone conversation, Mr. Jim Lecky of the National Marine Fisheries Service agreed with this assessment.

The threatened delta smelt is not likely to occur in the Sacramento River near the proposed construction sites because the project area is significantly upstream from the highest current and historic sightings. In addition, construction impacts to riverine aquatic habitat would be avoided. Therefore, it is our assessment that the delta smelt would not likely be adversely affected by the Phase III project.

A search of the California Natural Diversity Data Base (NDDB) (1994) revealed no occurrences of the threatened giant garter snake in the project area. However, suitable habitat does occur and would be destroyed by project construction. Surveys of the potential habitat would be conducted during the spring of 1996 to determine if the snake is present. If these surveys indicate that the snake is present, then formal consultation will be requested.

The NDDB (1994) contains no recorded sightings of the endangered bald eagle within the proposed project area. Although nesting is not expected to occur, it is possible that eagles will forage, perch, or roost in the area. However, if eagles do use the area, they are probably transient visitors and not likely to be adversely affected.

The NDDB (1994) has no recorded sightings of the endangered American peregrine falcon in the project area. Suitable nesting habitat does not appear to exist within the area. If peregrine falcons do use the project area, they are probably highly mobile winter transients and are not likely to be affected.

The NDDB (1994) contains no recorded sightings of the threatened Aleutian Canada goose in or near the project area. However, this bird may occasionally use the project area during its migration to wintering grounds. Due to the highly transient nature of its visits, however, it is unlikely that this bird would be adversely affected by the Phase III project.

The vernal pool tadpole shrimp, vernal pool fairy shrimp, conservancy fairy shrimp, and delta green ground beetle are found mainly in vernal pool habitat, which is not present in or near the project area. A search of the NDDB (1994) confirmed this finding. Since no suitable habitat for these invertebrates will be affected by the proposed project, no adverse impacts are anticipated.

While the NDDB (1994) reports just one occurrence of the threatened valley elderberry longhorn beetle in the immediate project area, beetle habitat exists along the river throughout much of the area. Since surveys by Corps biologists revealed that 1,333 stems greater than 1 inch in diameter may be affected by the proposed project, we request formal consultation.

The NDDB (1994) contains no records of the endangered palmate-bracted bird's beak or Solano grass in or near the project area. No suitable habitat for either plant exists in the project area so no adverse impacts are anticipated.

None of the proposed species is likely to occur in the project area or be affected by the project. The Sacramento splittail does occur in the Sacramento River near the project sites, but this habitat would be avoided during construction. All populations of the California red-legged frog on the valley floor are thought to have been eliminated so no impacts to this species are anticipated. Agricultural practices have made it very unlikely for Contra Costa goldfields to exist in the project area. Colusa grass is limited to vernal pool habitat, which is not present in the project area. The closest known extant occurrence of Hartweg's golden sunburst is more than 60 miles south of the project area. Analysis of project impacts on the other 23 species of concern are provided in the enclosed biological data report.

Please advise us if you concur with this biological assessment. Prior to completing the final signed version of your biological opinion, we request that you informally furnish us a draft copy for review. If you have any questions, please contact Debbie Giglio at (916) 557-5195.

Sincerely,

Daniel S. Herman
for Walter Yep
Chief, Planning Division

Enclosure

Copies Furnished:
Mr. Boyd Gibbons, Director, Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814
Mr. Jim Lecky, Endangered Species Coordinator, NMFS, South West Region, 501 West Ocean Boulevard, Suite 4200, Long Beach, California 90802
Mr. Raymond Barsch, General Manager, The Reclamation Board, 1416 Ninth Street, Room 455-6, Sacramento, California 95814

Biological Data Report

Sacramento River Flood Control System Evaluation
Phase III
Mid-Valley Area

U.S. Army Corps of Engineers
Sacramento District

May 1995

Table of Contents

Tables

Figure

Plate

Appendixes

1.0 Introduction

1.1 Purpose and Need

This Biological Data Report was prepared for the Sacramento River Flood Control System Evaluation, Phase III, in compliance with Section 7(c) of the Endangered Species Act. The report discusses the species of concern occurring within the general vicinity of those parts of the levee system which are under consideration for reconstruction. The proposed project involves modification of existing levees within the Mid-Valley Area of the Sacramento River flood control system (figure 1) in order to restore them to design conditions originally authorized by Congress in 1919.

The U.S. Fish and Wildlife Service (FWS) listed 57 species of concern (Appendix A) as potentially occurring in the study area. Thirteen of these are Federally listed as threatened or endangered, 5 are proposed for listing, and 39 are candidates for listing. In addition, a search of the California Natural Diversity Data Base (NDDB 1994) revealed that three State-listed threatened species may occur in the project area.

The following information regarding the Federal and State species of concern is included in this report: current legal status, distribution, habitat requirements, the status of the populations in the proposed project area, possible reasons for endangerment, and an analysis of the potential impact of the project on these species. This information is necessary to determine what mitigation measures might be required to avoid, minimize, or compensate for impacts to any of these listed species.

1.2 Project Area

The Mid-Valley project area lies primarily to the north and west of the Sacramento Metropolitan area in the Central Valley of California, encompassing portions of Sutter, Yolo, Placer, Yuba, and Solano Counties. The project area includes Knights Landing Ridge Cut, Yolo and Sutter Bypasses, and the Sacramento and Feather Rivers. The study area includes portions of the Sutter, Tisdale, Sacramento, and Yolo Bypasses; portions of Bear River; Yankee Slough; Dry Creek; east levee of the Knights Landing Ridge Cut; Coon Creek Group Interceptor; Western Pacific Intercept Canal; and the Natomas Cross Canal.

Agriculture dominates land use in the Mid-Valley Area. Orchards, row crops, and grains are grown on much of the land, and irrigation water is diverted from the rivers. Portions of the Yolo and Sutter Bypasses are within the Mid-Valley Area. The bypasses convey overflow from the Sacramento River during the flood season and are farmed during the non-flood season. A part of the Sutter Bypass is also designated as a national wildlife refuge.

Sacramento River Flood Control System Evaluation

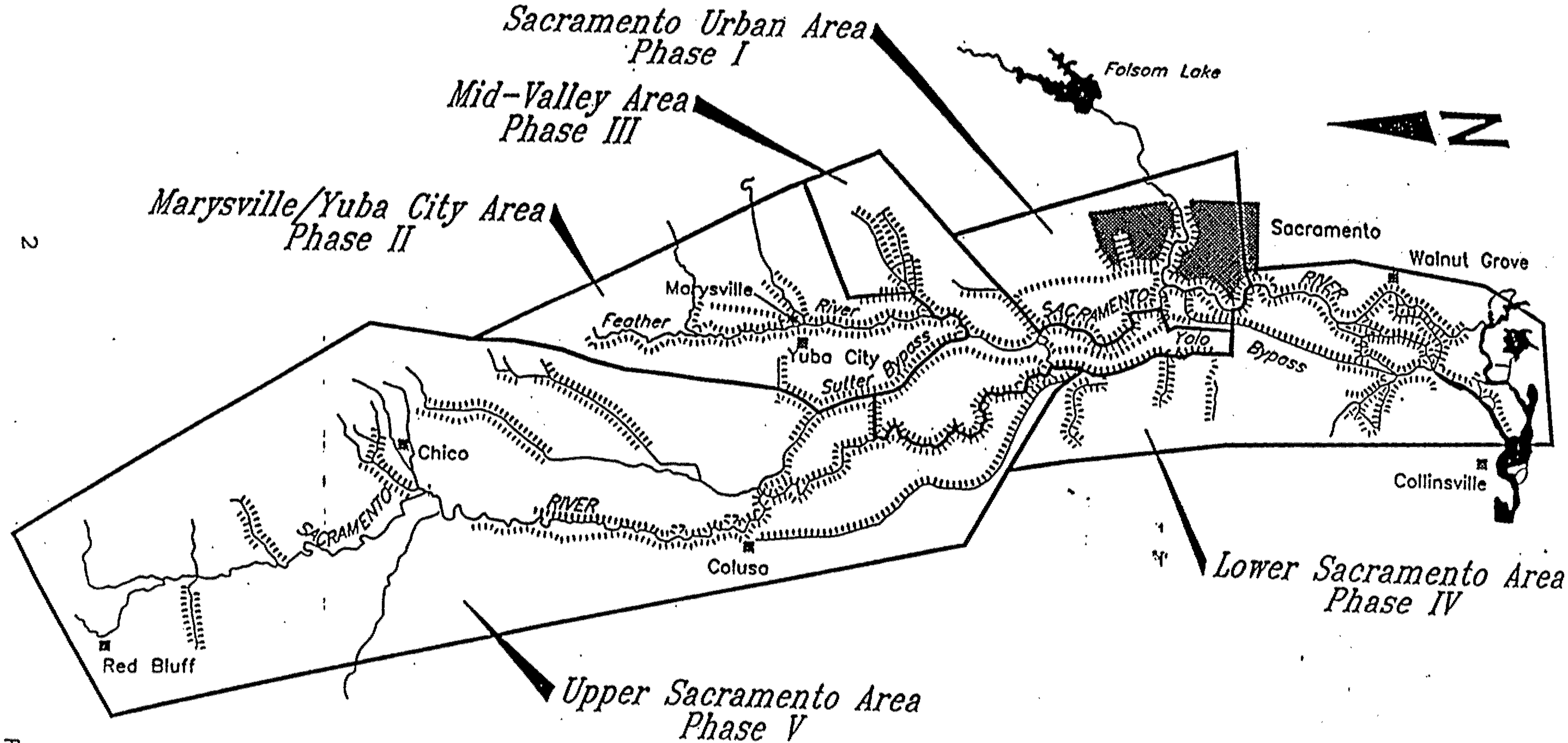

FIGURE 1
General Mar

Six different habitat types have been identified in the Mid-Valley study area. These include grassland, wetlands/marshes, scrub/shrub, riparian woodland, agricultural lands, and shaded riverine aquatic cover. These habitats are critical to the survival and reproduction of fish and wildlife in the area.

1.3 Project Description

A. Background The Mid-Valley Area repair project is Phase III of the Sacramento River Flood Control System Evaluation conducted to ensure that system levees constructed are stable and are providing the full benefits envisioned by Congress at the time of authorization. The Sacramento River Flood Control System Evaluation has been divided into five phases. The first phase consisted of an evaluation of levees in the Sacramento Urban Area. The study was started after the 1986 flood severely stressed the existing levee system in the study area, caused levee failures, and raised questions of levee reliability. Phases II-V were addressed in general terms in a programmatic Environmental Impact Statement/Environmental Impact Report (EIS/EIR) that was finalized in June 1992. Site specific environmental documentation for Phase II was completed in April 1993. Environmental documentation for Phases IV and V will be developed in the future.

The Phase III study area (Mid-Valley Area) of the Sacramento River Flood Control System Evaluation includes 200 miles of project levees along the Sacramento and Feather Rivers, portions of the Yolo and Sutter Bypasses, and Knights Landing Ridge Cut. Of the 200 miles of levees in the project area, about 18.27 miles of levee modification are recommended as shown in plate 1. Table 1 shows the type of repair and length of each site.

B. Proposed Action and Alternatives

Technical studies indicate potential levee embankment problems and freeboard deficiencies. Alternatives developed address these inadequacies. With the exception of the construction alternative involving a cutoff wall at waterside levee toe and the no-action alternative, alternatives being considered for levee reconstruction would generally consist of work on the crown or landward side of the levees, thus minimizing impacts to riverside riparian habitats.

No Action Alternative

No action. No levee construction would be considered in this alternative. This alternative would likely result in levee failure for flood events of lesser magnitude than specified for design conditions, economic damages, and possible loss of life. The overall extent of damages would depend on several factors, including magnitude and duration of flooding, and the success of emergency flood fighting efforts. Significant costs could be incurred for reconstruction of structures damaged by floods (FWS, 1995).

Table 1. Site locations, proposed remedial repair work alternatives, miles impacted, and acres impacted for the Sacramento River Flood Control System Evaluation, Phase III project.			
SITE #, LOCATION, AND RIVER MILE	PROPOSED REMEDIAL REPAIR WORK	MILES IMPACTED	ACRES IMPACTED
1-Sutter Bypass 17.9-18.6R	Seepage interceptor trench drain	0.70	0.09
2-Sutter Bypass 13.75-14.75R	Seepage interceptor trench drain	1.00	0.12
2-1 Sutter Bypass 4.22R	Seepage interceptor trench drain	0.05	0.01
2-2 Sutter Bypass 4.89R	Seepage interceptor trench drain	0.05	0.01
2-3 Sutter Bypass 7.67R	Seepage interceptor trench drain	0.05	0.01
2-4 Sutter Bypass 9.13R	Seepage interceptor trench drain	0.03	0.01
2-5 Sutter Bypass 9.53-9.60R	Seepage interceptor trench drain	0.06	0.01
2-6 Sutter Bypass 10.32-10.38R	Seepage interceptor trench drain	0.06	0.01
2-7 Sutter Bypass 12.09R	Seepage interceptor trench drain	0.03	0.01
2-8 Sutter Bypass 15.45R	Seepage interceptor trench drain	0.02	0.01
2-9 Sutter Bypass 16.12R	Seepage interceptor trench drain	0.03	0.01
2-10 Sutter Bypass 17.14R	Seepage interceptor trench drain	0.03	0.01
3-Sutter Bypass 2.0-3.0R	Lime treatment, ditch relocation	1.00	14.65
4-Sacramento River 116.2-117.2L	Seepage/stability berm/toe drain	1.00	14.60
5-Sacramento River 109.9-110.5L	Fill seasonal ditch, reshape landside toe	0.60	5.14
6-Sacramento River 104.8-105.7L	Seepage/stability berm/toe drain	0.87	12.67
7-Sacramento River 85.2-85.9L	Seepage/stability berm/toe drain	0.70	10.19
9-Sacramento River 87.1-87.3R	Seepage/stability berm/toe drain	0.20	1.93
10-Sacramento River 86.8-86.9R	Seepage/stability berm/toe drain	0.10	1.38

11-Sacramento River 85.2-85.6R	Seepage/stability berm/toe drain	0.40	5.51
12-Knights Landing Ridge Cut	Lime treatment, ditch relocation, reshape levee	2.17	43.82
12A-Knights Landing Ridge Cut	Lime treatment	0.85	10.33
13-Knights Landing Ridge Cut	Lime treatment, ditch relocation	0.38	6.47
14-Sacramento River 80.8-81.5R	Seepage/stability berm/toe drain	0.70	10.19
15A-Yolo Bypass	Restore levee crown, lime treatment, ditch relocation	1.32	20.25
15B-Yolo Bypass	Restore levee crown, lime treatment	4.82	51.24
17-Feather River 2.2-2.4L	Seepage/stability berm or cutoff wall	0.20	2.57
18-Feather River 0.78-0.93L	Cutoff wall or seepage/stability berm	0.15	2.57
19-Feather River 0.35-0.55L	Seepage/stability berm and fill ditch	0.20	2.75
20-Sacramento River 79.0-79.5L	Seepage/stability berm/toe drain	0.50 TOT 18.27	7.71 TOT 224.28
Borrow Site 1, near Tisdale Weir Borrow Site 2, near Fremont Weir Borrow Site 3, near Cache Creek Setting Basin			20.00 48.00 40.00 TOT 108.00

*Taken from FWS Draft CAR 1995

Construction Alternatives

Seepage stability berm. This alternative would consist of constructing drainage improvements and berms at the landside toe of the existing levee embankment. A drainage blanket would be placed along the lower landside slope and extend landward of the landside toe with a stability earth berm constructed over the drainage blanket. Direct construction impacts would consist of removing vegetation (clearing and grubbbing) along the landside toe to as much as 60 feet beyond the toe as well as about 10 feet up the lower landside levee slope. Generally, there would be no berms constructed where ramps or raised areas around existing structures are located. The seepage stability berm/toe drain alternative described below is a variation of the seepage stability berm alternative. Both designs have the same surface impacts to vegetation. The stability berms would counteract hydraulic seepage pressure within the levees during high flows, thus improving levee stability at the landside levee toe.

Seepage stability berm/toe drain. This alternative would consist of constructing drainage improvements and/or stability berms at the landward toe of the existing levee embankment. Toe drains would be constructed about 1 foot wide and 5 feet deep adjacent to the levee toe. A pipe would be placed at the bottom of the toe drain, and the excavated a filled with imported coarse material. A seepage/stability berm on the lower landside levee slope and adjacent toe area would be constructed as described in the above alternative. The toe drains would intercept and convey seepage waters away from the toe of the levee. Th stability berms would counteract hydraulic seepage pressure within the levees during high flows, thus improving levee stability at the landside levee toe.

Levee crown restoration. This alternative would consist of raising the existing levee crown elevation in reaches which do not have the minimum required design freeboard above the design water surface. Site impacts would consist of removing vegetation (clearing and grubbing) on the top of the levee crown, and possibly 1 to 2 feet on the waterside and landside slopes where fill material may be placed to meet the existing slope.

Constructing slurry trench cut-off walls. This alternative would consist of digging a trench down the middle of the levee or along the waterside toe and filling it with cement, bentonite, and other material, thus improving structural stability. The impervious material significantly reduces the movement of water through the levee, prevents piping of the levee or foundation material, and prevents landside levee boils during floods. To function successfully, the cutoff wall must be keyed into a relatively impervious clay or silt foundation. Remediation using slurry cutoff wall through the levee crown is most appropriate in places where development is close to the levee toe (within 75 feet). A 3-foot-wide trench would be dug in the center of the levee crown or along the waterside toe which would extend into the levee foundation. This trench would then be filled with the appropriate material to minimize seepage through the levee. Direct construction impacts would consist of removing vegetation (clearing and grubbing) on the levee crown or along the waterside toe and using a trenching machine, backhoe, and other equipment along the

waterside toe or on the top of the levee. For the waterside toe slurry wall, the waterside slope would have a bentonite layer applied. A staging area would be used to mix the cement, bentonite, and other materials which would be pumped into the excavated trench. The cutoff wall alternative may require no additional right-of-way. However, traffic on the top of the levee, such as Garden Highway in RD 1001, would have to be rerouted if the cutoff wall was constructed through the levee crown.

Lime treatment. This alternative would consist of removing a 4-foot depth of levee material from the crown and landside slope to about 10 feet beyond the levee toe, stockpiling the material, mixing it with lime, and recompacting it to an established landside slope. The levee slopes and crown would be reconstructed during the process. Direct construction impacts would consist of generating lime dust and removing vegetation (clearing and grubbing) on the crown and landside slope to about 10 feet beyond the toe, and about the top 5 feet of the waterside slope. Measures would be taken by the contractor to control lime dust.

Filling and/or relocating existing drainage ditches. Direct construction impacts would consist of filling an existing ditch or digging a new ditch. Fill for the existing ditch may consist of materials excavated from the new ditch. No work would be done on the existing levee slope, except possibly construction of an access ramp if needed. Temporary construction impacts would also occur from trucked and wheeled machinery to move fill or excavate materials.

Seepage interceptor trench drain. This alternative would consist of cutting a 15-foot-deep trench, about 2 feet wide, and filling it with sand. Every 300 feet, a perpendicular French drain or piping would empty into the adjacent irrigation canal. Direct construction impacts would consist of removing vegetation (clearing and grubbing) along the landside toe to about 10 feet beyond the toe, and clearing and grubbing an area about 10 feet wide perpendicular to the levee and extending from the toe to the adjacent irrigation canal.

2.0 Methodology

2.1 Consultations

The FWS was consulted for a list of species protected under the Endangered Species Act. Experts at the FWS, California Department of Fish and Game (DFG), and the National Marine Fisheries Service (NMFS) were contacted to obtain descriptions of the habitat requirements for the special status species and to determine their presence or absence in the study area.

2.2 Literature Search

Additional information for this report was derived from the files of the Environmental Resources Branch of the Corps. The files contain information compiled from a variety of sources including books, journals, and various government publications. In addition, a search of the NDDB (1994) was conducted. The results of this search are shown in table 2.

2.3 Overview of Federally Listed Species

The Corps asked the FWS to identify endangered, threatened, proposed, and candidate species that might occur in the project area. Proposed and candidate species are not afforded the same level of protection under the Endangered Species Act as listed species, but the presence and possible impacts to the proposed and candidate species were assessed to prepare for the possibility that they may be listed before the project is completed. Of the 39 candidate species, 23 were assessed and 16 were not. The 23 assessed species were originally identified as possibly occurring in the project area. The other 16 candidate species are late inclusions and are not in this report; however, if the status of any of these species should change to proposed during construction, additional assessments would be prepared.

The FWS identified 13 listed species and 5 proposed species that may be present in the project area. Of the 13 listed species, 7 were endangered and 6 were threatened. Of the 5 species proposed for listing, 3 are proposed endangered and 2 are proposed threatened. Of the 39 candidates for listing, 2 are Category 1 Candidates, 1 is recommended for Category 1 Candidate status, 34 are Category 2 Candidates, and 2 are recommended for Category 2 status.

2.4 Overview of State Species of Special Concern

A search of NDDB revealed that three State-listed species which are not Federally listed that may occur in the project area. Two species are listed as threatened and one is listed as endangered by the State of California.

Table 2. Summary of California Natural Diversity Database Results

Species	Federal Listing	State Listing	In Project Area	Near Project Area
Plants				
adobe lily	Category 2	none	No	No
alkali milk-vetch	Recommended (C2)	none	No	No
Colusa grass	Proposed Threat.	Endangered	No	No
Contra Costa goldfields	Proposed End.	none	No	No
delta tule-pea	Category 2	none	No	No
Ferris's milk-vetch	Category 2	none	No	No
fragrant fritillary	Category 2	none	No	No
Hartweg's golden sunburst	Proposed End.	Endangered	No	No
hispid bird's-beak	Category 2	none	No	No
legenere	Category 2	none	No	No
Mason's lilaeopsis	Category 2	Rare	No	No
showy Indian clover	Recommended (C1)	none	No	No
palmate-bracted bird's-beak	Endangered	Endangered	No	No
recurved larkspur	Category 2	none	No	No
Solano grass	Endangered	Endangered	No	No
Suisun aster	Category 2	none	No	No
valley spearscale	Category 2	none	No	No
veiny monardella	Category 2	none	No	No
Invertebrates				
Conservancy fairy shrimp	Endangered	none	No	No
Sacramento Valley tiger beetle	Recommended (C2)	none	No	No
Valley elderberry longhorn beetle	Threatened	none	Yes	Yes
vernal pool fairy shrimp	Threatened	none	No	No
vernal pool tadpole shrimp	Endangered	none	No	No
delta green ground beetle	Threatened			
Fish				
delta smelt	Threatened	Candidate (Threat.)	No	No
green sturgeon	Category 2	none	No	No
longfin smelt	Category 2	none	No	No
Sacramento splittail	Proposed Threat.	none	No	Yes
winter-run chinook salmon	Endangered	Endangered	No	No

Table 2. Summary of California Natural Diversity Database Results
(continued)

Species	Federal Listing	State Listing	In Project Area	Near Project Area
Amphibians				
California tiger salamander	Category 1	none	No	No
western spadefoot toad	Category 2	none	No	No
California red-legged frog	Proposed End.	Sp. Special Concern	No	No
Reptiles				
giant garter snake	Threatened	Threatened	No	No
western pond turtle	Category 2	none	No	No
Birds				
American peregrine falcon	Endangered	Endangered	No	No
Aleutian Canada goose	Threatened	none	No	No
bald eagle	Endangered	Endangered	No	No
bank swallow	none	Threatened	No	Yes
Swainson's hawk	none	Threatened	Yes	Yes
tricolored blackbird	Category 2	none	No	Yes
white-faced ibis	Category 2	none	No	No
western yellow-billed cuckoo	none	Endangered	No	No
Mammals				
greater western mastiff bat	Category 2	none	No	No
Pacific western big-eared bat	Category 2	none	No	No

2.5 Valley Elderberry Longhorn Beetle (VELB) Surveys

The project area was surveyed by Corps biologists during spring of 1994 to determine the presence or absence of elderberry shrubs (*Sambucus* sp.), which are the host plant for the threatened Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*). Stems greater than 1 inch in diameter at ground level were counted, and emergence holes were noted. A total of 12 clumps containing 1,333 stems greater than 1 inch were documented at site 20. Four of the clumps (25 percent) had stems with emergence holes.

3.0 Species Accounts

3.1 Federal Listed Species

A. Fish

WINTER-RUN CHINOOK SALMON (*Oncorhynchus tshawtscha*)
Family: Salmonidae

Status: The winter-run chinook salmon was listed as a threatened species by the Federal Government in 1989. However, in January of 1994, the NMFS reclassified the salmon as endangered based on the continued decline and increased variability in run sizes. The State also lists the winter-run chinook as endangered.

Description: Winter run Chinook salmon are distinguishable from the other runs of chinook salmon in the Sacramento River by the timing of their upstream migration and spawning season. They return to the river for spawning almost exclusively as 3-year-olds, after having spent several years in the ocean (FWS 1990).

Adult migration past Red Bluff Diversion Dam on the Sacramento River starts in mid-December and continues into mid-August. The bulk of spawning occurs in May and June in the main stem of the Sacramento River upstream from Red Bluff. Juvenile seaward migration begins in August and continues through October, with a peak between mid-September and mid-October (FWS 1988).

Habitat: Winter-run chinook salmon require clean, free-running water for migration, spawning, and rearing. Clean gravels are essential for successful spawning. Water temperatures during spawning must be between 5.8°C and 14.2°C, although temperatures during migration and rearing can be slightly higher. Water velocities over spawning gravels should be about 2 to 3 feet per second. Fluctuations in flows should be minimal during spawning, incubation, and outmigration periods. During juvenile outmigration, fluctuations can cause juveniles to become stranded in side channels and bypasses (FWS 1988).

Distribution: Winter run chinook salmon once spawned in the upper Sacramento River drainage. Slater (1963 *in* USACE 1991) believed that the winter-run populations were historically restricted to the spring-fed McCloud River drainage. Regardless of the winter-run's historic range, the construction of Shasta dam in 1942 permanently truncated the available spawning habitat to the Sacramento River drainage below the dam. Currently, winter-run salmon spawn between Keswik Dam, just downstream of Shasta Dam, and Red Bluff Diversion Dam. In addition, limited numbers of salmon spawn below Red Bluff Diversion dam, but with low success (USACE 1991).

Project Area Occurrence: The winter-run chinook salmon is found in the project area in the Sacramento River.

Project Impacts: Construction activities would be limited to the crown and landside of the levees and thus should not affect Sacramento River water quality or shaded riverine aquatic (SRA) habitat. There would be no instream work. Sites 17 and 18 may require waterside work at the levee toe, 50 feet from the water. As a result, the proposed project should not affect the winter-run chinook salmon or its habitat (Lecky 1994).

Endangerment: The estimated winter-run chinook salmon population has declined dramatically from 60,000 to 120,000 in the 1960's to an average of just over 500 since 1990. The factors responsible for this precipitous decline are complex and numerous. Water diversion and impoundment, riparian habitat loss and bank modification, pollution, and fishery harvest are the most probable causes (FWS 1994, USACE 1991).

DELTA SMELT (*Hypomesus transpacificus*)
Family: Osmeridae

Status: The delta smelt is listed as a threatened species under the Endangered Species Act. In addition, it is a State candidate for threatened status.

Description: The delta smelt was described as follows by Moyle *et al.* (1989): a slender-bodied fish typically 60 - 70 mm in standard length (SL), although a few may attain 120 mm SL. Live fish are nearly translucent and have a steely-blue sheen to their sides. Occasionally there may be one chromatophore between the mandibles, but usually none is present. Its mouth is small, with a maxilla that does not extend past the mid-point of the eye. The eyes are relatively large; the orbit width is contained about 3.5 - 4 times in the head length. Small pointed teeth are present in the upper and lower jaws. The first gill arch has 27 - 33 gill rakers and there are 7 branchiostegal rays. There are 9 - 10 dorsal fin rays, 8 pelvic fin rays, 10 - 12 pectoral fin rays, and 15 - 17 anal fin rays. The lateral line is incomplete and has 53 - 60 scales along it. There are 4 - 5 pylorie caeca.

Habitat: The delta smelt spends most of its life in the shallow waters of the estuarian mixing zone where salinities range from 0 to 2 grams per thousand. However, the species spawns in fresh water at temperatures from about 7-15 degrees Celsius (°C). Most spawning

occurs in the dead-end sloughs and shallow edge-waters of channels. Hard substrates such as rocks, gravel, tree roots, and submerged branches are necessary for eggs to attach to. Once hatched, the pelagic larvae return to the estuarian mixing zone where they feed on copepods, cladocerans, and amphipods (FWS 1993).

Distribution: The delta smelt is endemic to the upper Sacramento-San Joaquin estuary in central California. Historically, it occurred from Suisun Bay upstream to the city of Sacramento on the Sacramento River and Mossdale on the San Joaquin River. Now, however, delta smelt are rare in Suisun Bay and more or less absent from Suisun Marsh where they once were common. Due to hydrology modifications (the shifting of the mixing zone), the delta smelt are now found mostly in the inferior habitat of the Sacramento River channel, upstream of Suisun Bay (Moyle *et al.* 1992 *in* FWS 1993).

Project Area Occurrence: The delta smelt probably spawns no higher than the confluence of the American and Sacramento Rivers (Pine 1994). The project area is significantly upstream of this point so it is unlikely that delta smelt would be present in the river near the construction sites.

Project Impacts: No adverse impacts to the delta smelt are anticipated because the project reaches of the Sacramento River are beyond the range of the smelt and all construction activities would generally be confined to the crown or landside of levees (Pine 1994). However, sites 17 and 18 may require waterside work at the levee toe, 50 feet from the water. Neither the smelt nor its habitat would be affected by the Mid-Valley project.

Endangerment: The decline of the Delta smelt has been attributed to modifications of Delta hydrology caused by water diversions and flood control projects, coupled with competition from introduced nonindigenous aquatic species and reduction in the abundance of important food organisms (FWS 1993).

B. Reptiles

GIANT GARTER SNAKE (*Thamnophis gigas*)
Family: Thamnophis

Status: The giant garter snake is a currently listed as threatened by both the Federal and State governments.

Description: *T. gigas* is one of the largest garter snakes, reaching up to 4.5 ft in length. It is dull brown in color with a checkered pattern of well separated black spots on the back. It has a dull yellow dorsal stripe and lateral stripes that are not developed. Its head is elongated with a pointed muzzle (DFG 1980).

Habitat: *T. gigas* generally inhabits marshy areas near permanent fresh water but will also inhabit marsh areas with temporary water such as sloughs, irrigation canals, drainage ditches,

and flooded rice fields. Giant garter snake habitats usually contain tule, cattail, blackberry, mustard, various thistles, and annual and perennial grasses (NDDB 1986). This vegetation, along with the burrows of rodents and crayfish, provides shelter from predation (Hansen 1986).

T. gigas is an aquatic feeder that specializes in ambushing fish underwater. It generally feeds on small fish such as carp (*Cyprinus carpio*), bullhead (*Ictalurus* sp.), mosquitofish (*Gambusia affinis*), and minnows. It will also feed on the larvae and young of the bullfrog (*Rana catesbeiana*) (Hansen 1982,1986).

During the active season from March to June, the giant garter snake must bask in sunny expanses of emergent or streamside vegetation in order to raise its body temperature. In the dormant season accessible upland retreats with suitable shelter are necessary during periods of flooding or runoff (Hansen 1986).

Distribution: Historically, the range of the giant garter snake was the Central Valley from the vicinity of Sacramento and Antioch southward to Buena Vista Lake near Bakersfield in Kern County (Hansen 1980). The reclamation of wetlands for agriculture has destroyed much of the original habitat. *T. gigas* is currently be limited to Fresno, Merced, San Joaquin, Sacramento, Yolo, Butte, Sutter and Solano Counties (Hansen 1986).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. However, the giant garter snake may be present undetected in irrigation ditches in the project area (Sorensen 1994). Surveys would be conducted between April 15 and June 1 in 1996 to determine its presence in these areas.

Project Impacts: Possible project impacts include injury or death of individual garter snakes as a result of construction activity and the loss or disturbance of supporting habitat. Danger to the snake from construction activities is greatest during the winter dormant period (November through March) when snakes are inactive below ground and unable to flee humans and machinery. If surveys reveal the snake's presence in the project area, formal consultation would be initiated with the FWS as required by Section 7 of the Endangered Species Act.

Endangerment: *T. gigas* faces endangerment from three factors: urbanization, agriculture, and the introduction of predator and competitive species. Urban development has dramatically changed its habitat through pollution, destruction of its food sources, and conversion to green grass landscapes. Wetlands have been drained, and streams have been rerouted through pipes or concrete channels to create sites for urban development and agriculture. *T. gigas* have been lost during the operation of farming equipment. Livestock grazing has deleted protective plant cover and compacted the soil resulting in the destruction of underground retreats. The effects of DDT and other pest control chemicals are currently unknown. Large predatory fish species introduced into many permanent waterways compete with *T. gigas* for smaller forage fish (Hansen 1986).

C. Birds

BALD EAGLE (*Haliaeetus leucocephalus*)
Family: Accipitridae

Status: The bald eagle is listed as endangered by both the State and Federal governments. As of February 1990 the FWS announced it would undertake a comprehensive study of bald eagle populations to determine if the species would warrant reclassification from endangered to the less critical threatened category.

Description: Adults eagles are brownish-black with white head, neck, and tail. The females are larger than the males as is common in most raptors. The wingspan ranges from about 6.5 - 8.0 ft. and weights range from 8.0 - 14.0 lbs. The plumage of young birds is mostly brown and blotched irregularly with white or buff colors. As the birds approach maturity, 4 or 5 years of age, the head, neck, and tail become progressively whiter over several annual molts (DFG 1985).

Habitat: Historically, bald eagles utilized a wide variety of habitat types and nesting materials. These include coastal cliffs and pinnacles, mountain pinnacles and caves, coastal deciduous and evergreen trees, interior riparian trees, coastal redwoods, and interior coniferous trees. (See Detrich (1986) for a list of tree species.) Eagle nests are typically found in multi-storied stands with old-growth components. They are always found near bodies of water which support a sufficient prey base. California eagles build their nests 500m from the nearest water body on average. Often times they will build alternate nests in the same territory and vary use between them in different years (FWS 1986).

At least three important factors are thought to influence bald eagle selection of wintering habitat. These include: (1) the presence of productive forage areas near by , (2) seclusion from human disturbance, and (3) the presence of dense stands of timber for diurnal perching and nocturnal roosting (Paruk 1987).

Distribution: Historically, the bald eagle habitated all of the North American continent and used breeding grounds on most of the continent (FWS 1986). Breeding grounds have decreased and now only include Alaska, Canada, the Pacific Northwest states, the Great Lake states, Florida, and Chesapeake Bay. The winter range includes most of the breeding range but extends mainly from southern Alaska and southern Canada southward (FWS 1986a).

Project Area Occurrence: A search of the NDDB revealed no occurrences in or near the project area. However, potential roosting habitat is present, and it is possible that bald eagles may occasionally visit near the project area to forage. No breeding sights are known or likely in the project area (Sanchez 1994).

Project Impacts: If bald eagles do occur in the project area, they would be infrequent, transient visitors. Removal of mature trees and snags can result loss of roosting and perching habitat for eagles. Construction activities and noise may disturb any wintering eagles present or near construction sites. If eagles are observed in or near the project area, then construction activities should be avoided between October and March when eagles may use the area.

Endangerment: Bald eagle populations have declined throughout their range since the beginning of the Anglo-American settlement (Detrich 1986). The decline accelerated with the beginning of widespread pesticide use in the 1940's. Other major factors contributing to eagle population declines and decreases in distribution were and continue to be habitat loss, illegal shooting, and electrocution from transmission lines (USFWS 1986, Detrich 1986, National Wildlife Health Laboratory 1985)

AMERICAN PEREGRINE FALCON (*Falco peregrinus anatum*)
Family: Falconidae

Status: The Peregrine Falcon is currently listed as endangered by the Federal and State governments. Studies are being conducted to determine if the falcon should be downgraded to the less critical threatened category.

Description: Adult peregrine falcons are outwardly similar but the female is larger. This falcon is 15-20 inches long and has a wingspread of 43-46 in. The wings are long and pointed. Adults are characterized by a slatey back and pale underparts, with spots and bars. Young birds are dark brown above and heavily striped below. The peregrine's flight pattern resembles that of the domestic pigeon (Terres 1980).

Habitat: Peregrine falcon habitat basically consists of nesting, perching, roosting and foraging areas in relatively open country. Some winter movement may occur, particularly in the northern part of the range (FWS 1982).

The American peregrine falcon nests almost exclusively on cliffs, usually near water. Tree nesting is virtually unknown in this population, and nesting on man-made structures is rare. There are records of nests on dunes or other low mounds, but these are infrequent and no recent records exist. Characteristics of nesting cliffs appear to be sheer cliffs of 150 ft. or more in height and a small cave or overhung ledge large enough to contain 3 or 4 full-grown nestlings. Suitability of the cliff is enhanced by several holes or ledges that can be used in alternate years as nests (FWS 1982).

Common foraging grounds for the bird generally include wooded areas, open grasslands, coastal strands, and bodies of water. Wooded areas near water attract a diverse avifauna, and bodies of water provide open areas where prey cannot easily escape attack. Marshes, savannas, and shorelines are also common foraging areas (FWS 1982).

Distribution: Historically the peregrine falcon was one of the most widely distributed of all bird species. Peregrines were recorded in most every major land mass of the earth except Antarctica and were found breeding over most of the range (Hickey 1969). Three subspecies were known in North America. The American peregrine falcon has historically nested throughout North America from the boreal forest south into Mexico wherever suitable nesting and foraging habitat occurred (FWS 1982).

Currently the peregrine falcon is distributed throughout California. Productivity enhancement by State and Federal agencies has contributed to the rise of the peregrine populations. Captive breeding and hatching are successful forms of enhancement. Of 211 peregrines hacked into the wild between 1974 and 1979, 71% reached the age of independence (FWS 1982).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. There is no suitable nesting habitat in the project area so it is unlikely that the peregrine falcon exists there. If they do use the area, they are probably winter transients and highly mobile (Pine 1994).

Project Impacts: No adverse impacts to the peregrine falcon are anticipated. As previously mentioned, if falcons do use the project area, they are probably winter transients and not likely to be affected (Pine 1994).

Endangerment: Previous endangerment was due to the use of pesticides such as DDT and DDE. Egg shell thinning and behavioral differences caused by the pesticides increased mortality and decreased reproduction habits. Once the breeding population was reduced, natural mortality factors became significant contributors to the further decline of this species (FWS 1982).

ALEUTIAN CANADA GOOSE *(Branta canadensis leucopareia)*
Family: Anatidae

Status: The Aleutian Canada goose was Federally listed as an endangered species in 1967. In December of 1990 it was reclassified as threatened. The Aleutian Canada goose has no State listing.

Description: A small race of Canada goose averaging 1,700 to 2,000 grams. Typical coloring is black head and neck, white cheek patches, dark back and wings, white rump, and black tail feathers, legs and feet. *B. c. leucopareia* is distinguished by a conspicuous white neck ring at the base of the neck (usually greater than 10 mm wide), subtended by a ring of darker feathers. Cheek patches are usually separated by a black line under the throat. The similar appearing cackling Canada goose is smaller in size and has a darker breast color, whereas Traverner's Canada goose are larger and have a lighter breast color. Both these subspecies sometimes have white neck rings but they are usually narrow or indistinct (FWS 1982).

Habitat: The Aleutian Canada goose utilizes a wide variety of habitats, including pasturelands and row crops such as corn, wheat, oats, barley, and rice. Artificially impounded waters such as farm ponds, sewage lagoons, duck clubs and small lakes, as well as intermittently flooded low lying areas are used as roosting sites (FWS 1982).

Distribution: The Aleutian Canada goose once bred throughout the eastern and western Aleutian Islands and wintered in California and the Oregon coast. Today, despite many efforts to reintroduce it on other islands, it breeds only on Buldir Island in the western Aleutians and on Chagulk Island in the eastern Aleutians (FWS 1982). Major use areas for wintering Aleutian Canada geese have been recognized near Colusa in the Sacramento Valley, near Modesto and Los Banos in the San Joaquin Valley, and near Crescent City (Beall 1980).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of Aleutian Canada goose in or near the project area. However, the Aleutian Canada goose may migrate through the Mid-Valley project area to forage and rest.

Project Impacts: No adverse impacts to this species are anticipated since neither its nesting nor wintering habitat would be affected. However, the goose may be reluctant to forage and rest in areas with construction activities. There is an abundance of Aluetian Canada goose habitat throughout the Mid-Valley area therefore, there should be no adverse affects.

Endangerment: Several factors may have contributed to the initial decline of the Aleutian Canada goose. The most important of these was probably the introduction of the Arctic fox to the Aleutian breeding grounds of the geese. Foxes were first released on the islands in 1836 for fur-farming purposes. It is thought that the foxes fed on the geese, over time decimating their numbers and bringing them close to extinction. Buldir was one of the few islands that escaped the Arctic fox introduction. Other factors that may have hastened the geese's decline include over hunting and loss of habitat at the California wintering grounds (1982).

D. Invertebrates

VERNAL POOL TADPOLE SHRIMP (*Lepidurus packardi*)
Family: Triopsidae

Status: The vernal pool tadpole shrimp is a Federal proposed endangered species. It has no State listing.

Description: Tadpole shrimp have sessile dorsal compound eyes, a large shield-like carapace that covers most of the body, a pair of long cercopods at the end of the last abdominal segment and a flat, paddle-shaped supra-anal plate. Adults reach a length of 50 mm. The second antennae are minute or absent in both sexes. They move by gliding or swimming gracefully by complex beating of their 35 pairs of legs that pass in a wavelike

anterior-posterior direction (FWS 1992).

Habitat: Tadpole shrimp are primarily benthic animals that swim with their legs down. They climb or scramble over objects as well as plow along or in bottom sediments. They occupy the bottom underlying a body of water. Food items consist of organic detritus and living organisms that they capture, such as fairy shrimp and other invertebrates.

Females deposit eggs on vegetation and other objects on the pool bottom. The tadpole shrimp passes the dry months in the egg stage. The eggs hatch as the vernal pools and swales are filled with rainwater in fall and winter (FWS 1992, Eng *et al.* 1990).

Distribution: The vernal pool tadpole shrimp is found at 14 vernal pool complexes in the Sacramento Valley from the Vina Plains in Butte County south of the Sacramento area in Sacramento County and west to the Jepson Prairie region of Solano County (FWS 1992, Eng *et al.* 1990).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. This species is a vernal pool species, and since no vernal pools are within any of the construction sites, it is highly unlikely that any tadpole shrimp occur there.

Project Impacts: This project would not affect any vernal pools. Since tadpole shrimp occur only in vernal pools, no adverse impacts to the shrimp are anticipated.

Endangerment: Vernal pools and the other ephemeral bodies of water that form the habitat for this shrimp are imperiled by a variety of human-caused activities such as urban development, water supply/flood control activities, and conversion of land to agricultural use (FWS 1992, Eng *et al.* 1990).

VALLEY ELDERBERRY LONGHORN BEETLE (*Desmocerus californicus dimorphus*)
Family: Cerambycidae

Status: This species is Federally listed as threatened. It has no State listing.

Description: In general, female valley elderberry longhorn beetles (VELB) are characterized by somewhat elongate and cylindrical bodies with long antennae, often in excess of 2/3 of the body length. In contrast, male VELB are stout-bodied and their elytra (thickened, hardened forewings) are coarsely punctured with a metallic-green pattern of four oblong maculations, surrounded by a bright red-orange border. The border eventually fades to yellow on museum specimens. The maculations are fused on some males, more closely resembling the nominate subspecies. Antennae are about as long as the body or slightly shorter. Body length is approximately 13.0 - 21.1 mm. (USACE 1990). Both sexes of VELB are readily identified due to their distinctive appearance.

Habitat: The beetle is host specific, maturing in and feeding as adults on elderberry (*Sambucus* spp.). The VELB prefers to inhabit trees with a girth of 15 - 65 cm in dense riparian plant communities with a mature overstory and a mixed understory (USACE 1985, FWS 1994).

Distribution: VELB is endemic to moist valley oak woodlands along the margins of rivers and streams in the lower Sacramento and upper San Joaquin Valleys of California, where elderberry grows. Although the entire historical distribution of VELB is unknown, the extensive destruction of riparian forests of the Central Valley of California strongly suggests that the beetle's range may have shrunk and become greatly fragmented. There is little information on former abundance of VELB for comparison with current population levels (USACE 1990).

Project Area Occurrence: A search of the NDDB (1994) revealed several occurrences near the project area. Sites 12, 12A, and 20 have elderberries (habitat for the VELB) which may be affected by the proposed construction activities.

Project Impacts: Project alternatives requiring removal or addition of soils and/or vegetation may adversely affect any existing elderberry shrubs and thus negatively affect any VELB's using the shrubs. Surveys conducted by Corps biologists in July 1994 revealed that 12 clumps containing a total of 1,333 stems would be affected by the proposed project. Four of the 12 clumps (33 percent) had stems with emergence holes. In accordance with FWS mitigation guidelines (FWS 1994), the existing shrubs would be transplanted, and 3,999 new elderberry plants and 3,199 associated native plants would be planted at the mitigation site.

Endangerment: Due to the limited knowledge of VELB's life history and its ecological requirements, precise threats to its survival are difficult to enumerate. Clearly the primary threat to survival of the VELB has been and continues to be the loss and alteration of habitat by agricultural conversion, grazing, levee construction, stream and river channelization, removal of riparian vegetation, rip-rapping of shoreline, plus recreational, industrial, and urban development. During the past 150 years over 90 percent of the riparian habitat in California has been destroyed by such practices. Insecticide and herbicide use in agricultural areas may be factors limiting the beetle's distribution. The age and quality of individual elderberry shrubs/trees and stands as a foodplant for VELB may also be a factor in the beetle's limited distribution (USACE 1990).

VERNAL POOL FAIRY SHRIMP (*Brachinecta lynchi*)
Family: Branchinectidae

Status: The vernal pool fairy shrimp is a Federal proposed endangered species. It has no State listing.

Description: Vernal pool fairy shrimp have delicate elongated bodies, large stalked compound eyes, no carapace and 11 pairs of swimming legs. They move gracefully by beating their legs that pass in a wave-like anterior to posterior direction. The shrimp ranges in size from 10.9 to 25 mm in length. In males, the basal segment outgrowth below and posterior to the pulvillus is ridgelike. Females carry eggs in a pyriform ventral brood pouch (USFWS 1992).

Habitat: The vernal pool fairy shrimp lives in ephemeral freshwater habitats, such as vernal pools and swales with clear to tea-colored water. None are known to occur in running or marine waters or other permanent bodies of water. This species is most commonly observed in grass or mud-bottomed swales, earth sump or basalt flow depression pools in unplowed grasslands. The vernal pool fairy shrimp has been collected from early December to early May (USFWS 1992, Eng *et al.* 1990).

Distribution: This California endemic occupies the grasslands of the Central Valley, Central Coast Mountains, and South Coast Mountains. Its 29 known vernal pool sites range from the Bina Plains of Tehama County in the northern Central Valley, through most of the length of the Central Valley and eastern margin of the Central Coast Mountains Region, to the mountain grasslands north of Santa Barbara, a total of 615 km. Several disjunct populations are located 285 km. farther south on the Santa Rosa Plateau and in Skunk Hollow in Riverside County. The species was collected at elevations from 10 to 1,159 meters (USFWS 1992, Eng *et al.* 1990).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in the project area. There is no vernal pool habitat located in the project sites so the vernal pool fairy shrimp does not occur there.

Project Impacts: No vernal pools would be disrupted as a result of project construction. Therefore, no adverse impacts to this species are anticipated.

Endangerment: Vernal pools and the other ephemeral bodies of water that form the habitat for this shrimp are imperiled by a variety of human-caused activities such as urban development, water supply/flood control activities, and conversion of land to agricultural use (USFWS 1992, Eng *et al.* 1990).

CONSERVANCY FAIRY SHRIMP (Branchinecta conservatio)
Family: Branchinectidae

Status: The conservancy fairy shrimp is Federally listed as endangered. It is not listed by the state of California.

Description: The male of this species is about 1.1 inches (27 mm) long, the smallest being about 0.6 inch (14 mm)long. Females are about 0.9 inch (23 mm) long, the smallest being 0.6 inch (14.5 mm) long (Eng, *et al.* 1990).

Habitat: This species of shrimp is found only in vernal pools. All pools are found to be astatic and located in swales in Central Valley grassland.

Distribution: This California endemic has been found only in the grasslands of the northern two-thirds of the Central Valley and is known from only three disjunct localities: Vina Plains of Tehama County, the Jepson Prairie Reserve just east of Travis Air Force Base in Sacramento County, and northeast of Merced in Merced County (Eng, *et al.* 1990).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in the project area. There are no vernal pools in the project area so the conservancy fairy shrimp does not occur there.

Project Area Impacts: No vernal pools would be disrupted as a result of project construction. Therefore, no adverse impacts to this species are anticipated.

Endangerment: The vast majority of the pools that once supported the conservancy fairy shrimp have been converted to agricultural fields. Because of its present very limited distribution and the continued loss of its habitat to cultivation and urbanization, the continued existence of the species is endangered. It is considered among the most vulnerable of the Central Valley endemic species (Eng, *et al.* 1990).

DELTA GREEN GROUND BEETLE (Elaphrus viridis)

Status: The delta green ground beetle is Federally listed as threatened. It is not listed by the State of California.

Description: The delta green ground beetle has a metallic green coloration, has large pointed mandible and highly resembles the tiger beetle.

Habitat: Currently, the beetles predominantly inhabit the borders of vernal pools and Olcott Lake within the Jepson Prairie Preserve. Vernal pools, however, may not be the beetle's preferred habitat (U.S. Fish and Wildlife Service 1985). Vernal pools may represent areas that have not been cultivated or heavily grazed by cattle and sheep and the beetles may have formerly ranged throughout much of the Central Valley (U.S. Fish and Wildlife Service 1985).

Distibution: This species was described from a single specimen and the only locality data supplied was "California." The beetle's habitat remained unknown until 1974, when a student from the University of California, Davis, rediscovered it in the area now referred to as the Jepson Prairie Preserve, Solano County (U.S. Fish and Wildlife Service 1985). Since 1974, entomologists have seen or collected only 75 adult beetles in the Jepson Prairie Preserve, which is owned and protected by TNC (U.S. Fish and Wildlife Service 1985).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in the project area. The only known habitat for the beetle is the Jepson Prairie Preserve, which is located in Solano County.

Project Area Impacts: No adverse impacts to the delta green ground beetle are anticipated.

Endangerment: Although the historical distribution of the delta green ground beetle is unknown, the widespread disruption of wetlands and grassland habitat of the Central Valley since the mid-1800's suggests that the range of the beetle has shrunk and become fragmented (U.S. Fish and Wildlife Service 1985).

E. Plants

PALMATE-BRACTED BIRD'S BEAK (*Cordylanthus palmatus*)
Family: Scrophulariaceae

Status: The palmate-bracted bird's-beak is listed as endangered by both the State and Federal governments. The California Native Plant Society (CNPS) categorizes this plant on their 1B list with a Rarity-Endangerment-Distribution (R-E-D) code of 3-3-3: occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported; endangered throughout its range; and endemic to California (CNPS 1979, 1988).

Description: *C. palmatus* is 10 to 30 cm tall, gray-green, somewhat glandular, and soft-hairy. Leaves are 7 - 20 mm, somewhat oblong, and range from entire to 5-lobed. The inflorescence is a 50 - 150 mm dense spike. The outer bracts are leaf-like and the inner bracts are 15 - 20 mm long and 3 - 7 lobed. The flower's calyx is about 15 mm long. Corollas range from 15 - 20 mm and are whitish, finely puberent, with the sides often pale lavender and the middle lobe of the lower lip erect. *C. palmatus* flowers have two stamens and a glabrous style. Seeds are 2.5 - 3 mm, more or less reniform, deeply netted, wavy-crested, and dark-brown (Hickman 1993). Plants flower between June and October (CNPS 1977).

Habitat: This species of birds's-beak is found in seasonally flooded, saline-alkali (black-alkali) soils called pescadero clay of lowland flats and plains (CNPS 1977). It is commonly associated with iodine bush (*Allenrolfea occidentalis*), alkali heath (*Frankenia grandifolia* var. *campestris*), salt grass (*Distichlis spicata*), and pickleweed (*Salicornia* spp.) (CNPS 1989, 1988). The elevation range for this species is 0 - 60 m (Hickman 1993).

Distribution: Historically, this species inhabited scattered alkaline-areas in the Sacramento and San Joaquin Valleys. Of the eleven documented occurrences of *C. palmatus*, at least three and possibly six have been extirpated. Currently, four populations are known to exist: one is a small population within the Mendota Wildlife Management Area, in Fresno County; another is found near Woodland in Yolo County; a third is found in Livermore, Alameda

County; the fourth occurrence is located in the Colusa National Wildlife Refuge (FWS 1986, CNPS 1989).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. There is no habitat (alkali sink) for this species in the project area so it probably does not occur there (Fuller 1994).

Project Impacts: No adverse impacts to the palmate bracted bird's-beak are anticipated.

Endangerment: Habitat modifications by urban and agricultural development and uncontrolled off-road vehicle use currently pose the most serious threat to the continued existence of *C. palmatus* (FWS 1986b).

SOLANO GRASS (*Tuctoria mucronata*)
Family: Poaceae

Status: *T. mucronata* is listed as endangered by both the State and Federal governments. The CNPS categorizes this plant on their 1B list with a R-E-D code of 3-3-3: occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported; endangered throughout its range; and endemic to California (CNPS 1979, 1988).

Description: The stems of *T. mucronata* are ascending, becoming decumbent, and are less than 12 cm long. Leaves are 2 - 4 cm, curved outward, inrolled, and tapered to a fine point. The inflorescence is 1.5 - 6 cm and somewhat enclosed in upper sheath; spiklets are crowded. The glumes are 4 - 7 mm, subequal, short-pointed, and sometimes have 1 or 2 short lateral teeth. Spikelets typically contain 5 - 10 florets. Lemmas are 5 - 7 mm, 11-15-veined, with the central vein ending in a sharp point of less than 1 mm. The leema tips have a few minute teeth. Anthers are yellow and about 3 mm, then turn pinkish when drying. The fruit are about 3 mm in length, laterally flattened, widely oblong, and smooth (Hickman 1993).

Habitat: Solano grass inhabits vernal pools/lakes on Pescadero clay which retain water longer than typical vernal pools (FWS 1985).

Distribution: Currently, *T. mucronata* is known only from Olcott Lake in the Jepson Prairie Preserve in Solano County (FWS 1985).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of Solano grass in the project area. There is no habitat (vernal pools) for this species located at the project sites so it probably does not occur there (Fuller 1994).

Project Impacts: No vernal pools would be disturbed as a result of project construction. Therefore, no adverse impacts to Solano grass are anticipated (Fuller 1994).

Endangerment: Past activities which have threatened the species include grazing, collection of specimens, modifications of the watershead of the lake by various activities, motorcycle racing in the lake, and construction of Cook Lane through the middle of the lake. Energy development on the Jepson Prairie also poses a threat to the continued existence of the species (FWS 1985).

3.2 Federal Proposed Species

A. Fish

SACRAMENTO SPLITTAIL (*Pogonichthys marrolepidotus*)
Family: Cyprinidae

Status: The Sacramento splittail is a Federal proposed threatened species.

Description: The Sacramento splittail can grow up to 40 cm in length and is easily recognized by the enlarged upper lobe of the tail, small head, and barbels at the corner of its mouth. Its sides are a dull silvery gold, which gets duller with age. Its back is dusky olive grey. During the breeding season the paired and caudal fins are tinged with red-orange, and the males become darker and develop small white tubercles on the head (Moyle 1976).

Habitat: *P. marrolepidotus* lives mostly in slow-moving stretches of the Sacramento River and Delta and in small shallow sloughs and marshes. They are extremely tolerant of brackish water, unlike other members of the minnow family (Moyle 1976). Their habitat is usually lined with emergent vegetation that offers protection from larger fish and provides abundant sources of food. They are generally bottom feeders and will prey on a variety of organisms depending on the environment. Detritus is a major part of their diet along with arthropods, aquatic insect larvae, and earthworms in flooded areas (Daniels 1983).

P. macrolepidotus is an annual spawner and produces a large number of eggs per year. They are mature by their second winter and live a relatively long life. Spawning occurs between early March and mid-May and is usually associated with an increase in day length and temperature. It is likely that splittail spawn on vegetation (Daniels 1983).

Distribution: Historically, *P. macrolepidotus* inhabited a wide range of lakes and rivers in the Central Valley, but today seem to be confined to the lower delta region and the main channel of the Sacramento River. They are, however, the most abundant species of minnow in this area (Daniels 1983).

Project Area Occurrence: A search of the NDDB (1994) revealed one occurrence of Sacramento splittail at river mile 74.5 near the project area. It is possible that this fish inhabits the Sacramento River near many of the proposed construction sites.

Project Impacts: Since riverine aquatic resources would not likely be affected by project activities, it is unlikely that the splittail would be adversely affected (Pine 1994). However, sites 17 and 18 may require waterside work at the levee toe, 50 feet from the water.

Endangerment: The Sacramento splittail, although abundant within its habitat, occurs in a limited area. With environmental changes from introduced species and upstream water projects such as the increased use of water as coolant in powerplants, the splittail's abundance may decline rapidly (USFWS 1994, Daniels 1983).

B. Amphibians

CALIFORNIA RED-LEGGED FROG - (*Rana aurora draytonii*)
Family: Ranidae

Status: The California red-legged frog has been proposed for Federal listing as Endangered. In addition, it is listed as a Species of Special Concern by the California Department of Fish and Game.

Description: *R. a. draytonii* is 1.75 to 5.25 inches long with long back legs. Its lower abdomen and underside of its legs are red overlying a yellow background. Its head is usually dark with a white stripe on the jaw. Its back is dotted with small black flecks and large dark blotches with light centers on a background of brown, grey, olive or reddish brown (Stebbins 1985).

Habitat: *R. a. draytonii* is a pond frog that inhabits streamsides, grasslands, woodlands, and humid forests. It favors areas where cattails and other plants provide a good cover. It is most common in lowlands and foothills and usually near a permanent source of water. It may, however, appear far from water in damp woods or meadows after a rainfall (Stebbins 1985).

The breeding period is in the rainy months of January through April and only lasts 1 to 2 weeks (Stebbins 1985). Egg masses are laid in a water source on emergent vegetation so that the surface of the egg mass will just break the surface of the water (Hayes 1984). When not breeding, *R. a. draytonii* can be found in the damp woods.

Distribution: Historically, *R. a. draytonii* have ranged from Northern California south into Baja California and west of the Cascade-Sierra crest. Its habitat once included parts of the Central Valley and the Sierra Nevada foothills, but it currently appears to be absent from these regions. It inhabits elevations from near sea level to 8,000 feet (Stebbins 1985).

Project Area Occurrence: No sightings of the frog have been reported within or near the project area (NDDB 1994). California red-legged frogs are very rare in the Sierra Nevada foothills, and it is unlikely that any occur on the Sacramento Valley floor (Brode 1992).

Project Impacts: Since it is very unlikely that the California red-legged frog occurs within the project area, it is unlikely that this project would have an adverse impact on the species.

Endangerment: In the late 1800's and early 1900's, *R. a. draytonii* was heavily marketed as a source of frog legs. Females of the species were preferred over the males because of the females larger size. As a result, breeding activity was greatly reduced to where *R. a. draytonii* populations in the early 1900's were too minimal to record. Introduction of the bullfrog (*R. catesbeiana*) to California as an additional source of frog legs added to the decline in *R. a. draytonii* population due to the competition and predation from the bullfrog (Jennings 1985). Today the California red-legged frog faces endangerment because of habitat destruction such as the draining of wetlands for agriculture and urban development.

C. Plants

CONTRA COSTA GOLDFIELDS (*Lasthenia conjugens*)
Family: Asteraceae

Status: Contra Costa goldfields is a Federal proposed endangered species. The State of California has no listing for this plant. The CNPS categorizes the plant on their 1B list with a R-E-D code of 3-3-3; occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported; endangered throughout its range; and endemic to California (CNPS 1979, 1988).

Description: *L. conjugens* is showy spring annual, usually less than or equal to 40 cm high. The stem is simply or freely branched. The leaves are less than or equal to 8 cm long, linear, entire or pinnately lobed, and glaborous. The infloresence is hemispheric or obconic, and hairy; the involucre is 6 - 10 mm in diameter; there are 12 - 18 phyllaries which are fused together for less than or equal to half their length; and the receptacle is dome-shaped or obconic, glaborous or hairy. The inflorescence contains 6 - 13 ray flowers with ligules of 5 - 10 mm. It also contains many ray flowers with anther tips linear to more or less ovate and triangular style tips. The fruit is less than or equal to 1.5 mm, club-shaped, glaborous, and lacks a pappus. Contra costa goldfields flower between April and May (Hickman 1993, CNPS 1979, Munz and Keck 1959).

Habitat: *L. conjugens* is found in vernal pools in open, grassy areas in the valley and foothill woodlands at elevations less than 100 m. It was probably formerly found on costal prairies as well (Hickman 1993, CNPS 1979).

Distribution: Historically, the plant was found in Alameda, Contra Costa, Mendocino, Napa, Santa Barbara, Santa Clara, and Solano Counties. Currently, *L. conjugens* is found only in Solano and Napa Counties (Hickman 1993, CNPS 1979).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in the project area.

Project Impacts: No impacts are anticipated because no vernal pool habitat is present at the project sites.

Endangerment: The primar threat to Contra Costa goldfields is habitat loss due to urbanization and incompatib agricultural practices (CNPS 1979).

COLUSA GRASS (*Neostapfia colusana*)
Family: Poaceae

Status: Colusa grass is a Federal proposed threatened species. It is also listed as endangered by the State of California. The CNPS categorizes the plant on their 1B list with a R-E-D code of 1-3-3: rare but found in sufficient numbers and distributed widely enough that the potential for extinction is low at this time and endemic to California (CNPS 1988)

Description: Colusa grass is an annual with lower stem bases reclining on the ground and with the upper portion erect. Stems are 7 - 30 cm with pale green leaves loosely folded around the stem and with consecutive leaves emerging from the sheath of the former leaf. Pale green florets are arranged in a thick, spike-like, compound inflorescence which often have a thin, stringy, flowerless apical appendage. Each spikelet contains five florets and lacks glumes. Lemmas are very broad and fan-like with many veins and hairy-fringed margins. Anthers are rose-colored. Both Colusa grass and Orcutt grass exude a sticky, aromatic substance at maturity which hardens into brownish massas. Colusa grass can be distinguished from Orcutt grass and other grasses with similar growth habits by its lack of differentiation of the leaf into blade and sheath. *Neostapfia colusana* flowers from May to June (Munz and Keck 1968).

Habitat: Colusa grass occurs predominately on the adobe muds of large or deep vernal pools (preferred habitat), but also inhabits the alkaline banks of intermittent streams common to the Central Valley grassland communities of California (elevation 6 - 110 m). Although the best occurrences of Colusa grass are found in the absence of other vegetation, it can be associated with other valley vernal pool species. Commonly it is associated with *Orcuttia inaequalis* or *O. pilosa*. This grass requires dry summers in order to complete its reproductive cycle (Munz and Keck 1968).

Distribution: Colusa grass was once abundant in the lowest foothill "gooseland" vernal pools of Colusa and Stanislaus Counties. Today its distribution is restricted to scattered vernal pools in Stanislaus and Merced Counties and one large vernal lake (Olcott Lake on the Jepson Prairie) in Solano County (FWS 1993).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of Colusa grass in the project area. This species probably does not occur in any of the proposed construction sites because its habitat (vernal pools and intermittent streams with alkali banks) is not present.

Project Impacts: No adverse impacts to Colusa grass are anticipated.

Endangerment: Conversion of vernal pool habitat to agricultural uses is the primary reason for the decline of Colusa grass. Flood control work and use of vernal pool depressions for summer water sumps also threaten this species (FWS 1993).

HARTWEG'S GOLDEN SUNBURST (*Pseudobahia bahiifolia*)
Family: Asteraceae

Status: Hartweg's golden sunburst has been proposed for Federal listing as endangered. The State of California has classified it as an endangered species. The CNPS categorizes the plant on their 1B list with a R-E-D code of 2-3-3; occurrence confined to several populations or one extended population; endangered throughout its range; and endemic to California (CNPS 1988).

Description: *P. bahiifolia* is a woolly annual of 5 - 20 cm. Its leaves are alternate, 8 - 25 mm, linear-oblanceolate, and entire or 3-lobed. The inflorescence heads are solitary and radiate. Peduncles are 2 - 5 cm. The involucre is 5 - 6 mm and bell-shaped or hemispheric. The 3 - 8 elliptic-lanceolate phyllaries are arranged in one series. They are equal, fused at the base, and their margins are sometimes translucent. The receptacle is conic or hemispheric or naked. There is one ray flower per phyllary. The ligules are 5 - 10 mm, more or less ovate, yellow, and their tips are entire or slightly toothed. Disk flowers are about 2.5 mm and yellow, with long hairy bases and glabrous lobes. The fruit is 1.5 - 2.5. The flowering time is March to May (Hickman 1993, Munz and Keck 1959).

Habitat: The distribution of Hartweg's golden sunburst has been found to be closely correlated with the distribution of certain soil types, specifically highly acidic Amador soil. The plant occurs predominantly on the northern slopes of knolls in valley and foothill grassland plant communities, but it also can occur along shady creeks or near vernal pools. All the sites are characterized by a moderate to sparse cover of annual grasses associated with numerous species of native and non-native annual and perennial forbes. In general, this plant occupies valley and foothill grassland at altitudes between 50 to 460 feet (Stebbins 1990).

Distribution: Historically, Hartweg's golden sunburst was scattered and locally abundant in valley and foothill grasslands of the Central Valley. Currently fewer than 20 sites are known and several of these are classified as damaged, declining or possibly extirpated. The known *Pseudobahia bahiifolia* occurrences are concentrated in the eastern San Joaquin Valley in Stanislaus, Madera, and Fresno Counties (Stebbins 1990).

Project area occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. The Mid-Valley project area is outside (north) of the known range of this species. However, it may be present but undetected in the project area. If this species is listed before the project is constructed, then surveys would be conducted to determine its

presence in the project area.

Project Impacts: If Hartweg's golden sunburst is listed and surveys reveal its presence in the project area, then Section 7 consultation would be initiated as required with the FWS and a supplemental Biological Assessment (BA) would be prepared.

Endangerment: The decline of the status of the *P. bahiifolia* can generally be attributed to agriculture, overgrazing and land development. All extant occurrences of *P. bahiifolia* except a portion of one population are located on lands under private ownership and management. As a result, existing State and Federal laws are quite limited in their ability to regulate potentially detrimental human activities (Stebbins 1990, CNPS 1986).

3.3 Federal Candidate Species

A. Fish

GREEN STURGEON (*Acipenser medirostris*)
Family: Acipenseridae

Status: This species has been recommended for Federal Category 2 Candidate status. It has no State listing.

Description: Green sturgeon have blunt rounded snouts, with four barbels in a transverse row on the underside. The barbels are closer to the to the mouth than to the tip of the long, narrow snout. The mouth has highly protrudent lips but lacks teeth. Each fish has five widely separated rows of bony plates on the body, each plate with a sharp spine. The dorsal row of bony plates numbers 8 to 11, the lateral rows 23 to 30, and the bottom rows 7 to 10; the dorsal fin has 33 to 36 rays, the anal ray 22 to 28. The body is olive green with an olivaceous stripe on each side and one on the midline of the belly. Green sturgeon can reach 2.3 meters and 159 kilograms, though they seldom exceed 1.3 meters and 45 kg (Moyle 1976).

Habitat: Juveniles are common in freshwater areas, especially in the summer. A particularly heavy concentration was found in shallow water of the lower San Joaquin River in the summer of 1964. Tagging studies indicate that some green sturgeon travel long distances at sea, sometimes as much as 600 miles (Fry 1973). The diet of adult green sturgeon appears to consist of bottom invertebrates and small fish (Moyle 1976).

Distribution: Green sturgeon have been taken in saltwater from Ensenada, Mexico, to the Bering Sea. They are found in the lower reaches of large rivers from the Sacramento-San Joaquin on north, including the Eel, Mad, Klamath and Smith Rivers. They seem to be the most common sturgeon in the Klamath and Trinity Rivers and will migrate considerable distances upstream (Moyle 1976).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of the green sturgeon in or near the project area. However, the green sturgeon probably does occur in the Sacramento River near construction sites (Pine 1994).

Project Impacts: It is not likely that aquatic resources would be affected by project activities; therefore, it is unlikely that the sturgeon would be adversely affected (Pine 1994). If a direct water draw from any of the rivers is required for construction, the DFG and the FWS must first be consulted (Pine 1994).

Endangerment: The greatest threat to the green sturgeon is loss of spawning habitat.

LONGFIN SMELT (*Spirinchus thleichthys*)
Family: Osmeridae

Status: Longfin smelt is a Category 2 Candidate for Federal listing. It has no State listing.

Description: The longfin smelt is a small, thin, silvery fish with a large mouth (McGinnis 1984). The sides of the fish appear translucent silver and the back has an olive to iridescent pinkish green hue. This smelt has 8 to 10 dorsal fins, 18 to 21 anal rays, 10 to 12 pelvic rays, 38 to 47 gill rakers, and 4 to 6 pyloric ceca. It differs from other California smelts by its long pectoral fins, incomplete lateral line, weak or absent striations on the opercular bones, low number of scales in the later series (55 to 62), and long maxillary bones which extend just short of the posterior margin of the eye (Moyle 1976).

Habitat: Longfin smelt inhabit moderately saline waters in estuaries. They seem to prefer the middle or bottom of the water column on areas where the salinities are normally greater than 10 ppt. The primary food of this smelt is the opossum shrimp. The longfin smelt probably spawns from December through February in the lower reaches of rivers that feed the estuaries. It probably deposits its adhesive eggs either on rocks or aquatic plants, much like the delta smelt (McGinnis 1984, Moyle 1976).

Distribution: The longfin smelt is found in all major bays and estuaries from San Francisco Bay northward to Prince William Sound, Alaska. In north-central California, smelt spend the early summer in San Pablo and San Francisco Bays, then move into Suisun Bay in August. During winter, they spawn in the lower reaches of the Sacramento River (Moyle 1976).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. The longfin smelt probably does not spawn upstream on the Sacramento River where the proposed construction sites are located (Pine 1994).

Project Impacts: No adverse impacts to the longfin smelt are anticipated. Construction activities would generally be confined to the crown and landside of levees and would not affect the aquatic environment, however, sites 17 and 18 may require waterside work at the

levee toe, 50 feet from the water.

Endangerment: Just as the Delta smelt, the decline of the longfin smelt is probably related to modifications of Delta hydrology caused by water diversions and flood control projects, coupled with competition from introduced nonindigenous aquatic species (i.e., threadfin shad, inland silverside) and reduction in the abundance of important food organisms.

B. Amphibians

CALIFORNIA TIGER SALAMANDER (*Ambystoma californiense*)
Family: Ambystomatidae

Status: The California tiger salamander is a Federal Category 2 Candidate and a State Species of Special Concern.

Description: *A. californiense* is a large stocky salamander which is 6 - 16 cm long. It has small eyes, a broad, rounded snout and tubercles on the underside of its feet. This salamander has large pale yellow spots on a black background that are scarce or absent along the middle of the back. Individuals from southern coastal California populations have a few spots and a prominent cream band on the lower sides (Stebbins 1985).

Habitat: The adult California tiger salamander inhabits underground burrows of ground squirrels, badgers, and gophers. This salamander frequents quiet water ponds, reservoirs, lakes, and temperate pools and streams from arid sage brush plains and rolling grasslands to mountain meadows and forests. Adults emerge only for brief periods during nightfall to breed, usually during or shortly after rainfall. Breeding takes place in temporary rain pools, vernal pools, and permanent waters of grassland and open woodland of low hills and valleys (Stebbins 1985).

The breeding period is from December to February and the larvae require approximately 4 months to reach metamorphosis. The larvae diet consists mostly of tadpoles and to a lesser extent snails. The larvae swim very little and feed on whatever passes directly in front of them. Most feeding is done on the bottom, but larger larvae may swim toward the surface to capture prey (Anderson 1968).

Distribution: Historically, the tiger salamander was distributed throughout the Central Valley. However, this species has been extirpated from much of its former range due to agricultural and urban development (Stebbins 1985). Its current range is between the Sierra Nevada and the Coastal Ranges, extending north to Butte County and south to Kern and Tulare Counties. This species of salamander has been recorded at sites in the following counties: Tulare, Stanislaus, San Joaquin, Marin, Madera, Lake, Kern, Fresno, Contra Costa, Calaveras, Alameda, Sacramento, Butte, and Yolo (Hayes).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of the

tiger salamander in the project area. It is unlikely that this species occurs in the project area since its habitat (vernal pools and adjacent uplands) is not present there (Sorensen 1994).

Project Impacts: No adverse impacts to the California tiger salamander are anticipated.

Endangerment: The California tiger salamander is threatened by the continued loss and fragmentation of habitat due to agricultural and urban development. Most existing vernal pools have been altered allowing drainage or connection with semi-permanent canals. This results in contact with introduced species that prey upon the salamander larvae (centrarchid fish and bullfrogs). Heavy rains can also cause overflowing in the pool creating waterways of sufficient depth for fishes to invade the pools and consume nearly all the defenseless larvae (Hayes).

WESTERN SPADEFOOT TOAD (*Scaphiopus hammondi hammondi*)
Family: Pelobatidae

Status: Western spadefoot toad is a Federal Category 2 Candidate. It has no State listing.

Description: Adult western spadefoot toads are 4 to 6 cm in length. The eyes are large and protuberant with a vertically elliptical pupil. The tip of the snout is turned upward, giving a pug-dog profile; no bony lumps are between the eyes. They have a single prominent, rounded, sharp edged black spade on the foot. The skin is usually smooth and relatively thin, but sometime, small, round, tubercles tipped with orange or red appear. The color above is dusky green, gray or brown with scattered spots and darker blotches with irregularly outlined, creamy or whitish longitudinal stripes, one on each side of the midline, extending from the upper eyelids; and sometimes a similar stripe on each side extending backward from the ear region. Stripes are sometimes broken (Stebbins 1954).

Habitat: These nocturnal animals spend most of their time in underground burrows up to 36 inches deep (Stebbins 1972) which they construct themselves. Some individuals also use mammal burrows. Recently metamorphosed juveniles seek refuge in the immediate vicinities of breeding ponds for up to several days after transformation. They hide in drying mud cracks, under boards and in other surface objects including decomposing cow dung. Grasslands with shallow temporary pools are optimal habitats for the western spadefoot.

Breeding and egg laying occur almost exclusively in shallow, temporary pools formed by heavy winter rains. Egg masses are attached to plant material or the upper surfaces of small submerged rocks. Breeding and egg laying normally occur from late winter to the end of March. Eggs hatch quickly, usually within two weeks (Stebbins 1951).

Distribution: The western spadefoot ranges throughout the Central Valley and adjacent foothills and is usually quite common where it occurs. In the Coast Ranges it is found from Point Conception south to the Mexican border at elevations from sea level to 4,500 feet in the southern Sierra foothills. This species occurs primarily in grassland areas, but occasional

populations also occur in valley-foothill hardwood woodlands. Some populations persist for a few years in orchard-vineyard habitats.

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in the project area. Since its habitat (vernal pools) is not present in the project area, the western spadefoot toad is probably not found there (Sorensen 1994).

Project Impacts: No adverse impacts to the western spadefoot toad are anticipated.

Endangerment: *S. hammondi* is common where it occurs. As California's increasing population continues to encroach on the spadefoot's habitat, its populations are likely to decrease.

C. Reptiles

WESTERN POND TURTLE (*Clemmys marmorata*)
Family: Emydidae

Status: Both subspecies (*C. m. marmorata* and *C. m. pallida*) are category 2 candidates for Federal listing. Neither subspecies is listed by the State.

Description: Adults are commonly 5 to 6 inches in carapace length, and occasionally longer. The carapace is low, without median keel, and smooth in old adults; shields have concentric ridges in younger individuals and concentric and radiating ridges in immature. The plastron have six pairs of shields and broad bridge. The forelimbs have prominent scales, hind limbs less conspicuous ones; toes are webbed with prominent, slender nails (when unworn); the tail is usually less than one-third the carapace length. The carapace is olive with dark brown to blackish, with each shield marked with a network of spots, lines or dashes of brown or black which tend to radiate from growth centers (Stebbins 1954).

Habitat: Western pond turtles are associated with permanent or nearly permanent water such as ponds, lakes, streams, irrigation ditches or permanent pools along intermittent streams in a wide variety of habitat types below 6,000 foot elevation. Pond turtles bask on partially submerged logs, rocks, mats of floating vegetation, open mud banks, and other such sites. Turtles slip from basking sites to underwater retreats at the approach of humans or potential predators. Hibernation in colder areas is passed underwater in bottom mud. (Zeiner et al. 1988, Stebbins 1954).

Turtles seem to prefer the quiet water of ponds, small lakes, and sluggish streams, but are found also in rivers, clear streams, marshes and reservoirs. When in streams with considerable current, the turtle usually selects the quieter pools. It has occasionally been observed in brackish and even seawater (Stebbins, 1954). Food consists of aquatic plants such as pond lily pads, insects such as beetles, and carrion.

Females lay 3 to 11 eggs from March to August. Two distinct habitats may be used for oviposition. Along large slow-moving streams, eggs are deposited in nests constructed in sandy banks. Along foothill streams, females may climb hillsides, sometimes moving considerable distances to find a suitable nest site. Nests have been observed in a variety of different soil types, from sandy to very hard. Soil must be at least 4 inches deep for nesting (Stebbins 1954).

Distribution: The western pond turtle is common to uncommon in suitable aquatic habitat throughout California, west of the Sierra Cascade crest. The northern subspecies (*C. m. marmorata)* is generally found north of San Francisco Bay and the southern subspecies (*C. m. pallida*) is generally found south of this point. Both are absent from desert regions except along the Mojave River and its tributaries (Zeiner et al. 1988).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of either subspecies in or near the project area. Suitable habitat is present in the area, and it is possible that turtles exist there undetected (Sorensen 1994). If this species is listed before the project is constructed, surveys would be conducted to determine its presence in the project area.

Project Impacts: Turtle habitat possibly occurs in drainage ditches. Construction at sites 3, 5, 12, 13, 15A, and 19 may affect any turtles in the drainage ditch that would be backfilled at these sites. If this species is listed and surveys reveal its presence in the project area, then formal consultation would be initiated with the FWS as required by Section 7 of the Endangered Species Act to determine appropriate mitigation measures.

Endangerment: Hatchlings and juveniles are preyed upon by a variety of vertebrate predators, including certain fishes, bullfrogs, garter snakes, wading birds, and some mammals (Zeiner et al. 1988).

D. Birds

TRICOLORED BLACKBIRD (*Agelaius tricolor*)
Family: Emberizidae

Status: The tricolored blackbird is a species of special concern in California and a category 2 candidate for Federal listing.

Description: The bird is 7 to 9.5 inches long. The male is black, like the red-winged blackbird except with a darker red shoulder patch. This patch is bordered by white in the tricolored versus yellow in the red-wing. The female is also similar to the female red-wing but is a shade darker. The lower breast and back are a sooty color (Terres 1980).

Habitat: These birds lived in enormous numbers in the interior valley of California and north into Oregon. This is one of the most highly gregarious (living in flocks) birds of

North America. Habitat usually consists of open valleys and foothills, rarely at high altitudes, in streamside timber, alfalfa and rice fields, and tules and cattails in marshes and edges of reservoirs. Foraging occurs in grain fields (Terres 1980).

Distribution: *A. tricolor* breeds from southern Oregon (Tule and Klamath Lakes) south through California; mainly in the Central Valley and near the coast from Sonoma County south to northwestern Baja California. It winters mainly in the California portion of its range (Peterson 1961).

Project Area Occurrence: Several occurrences of tricolored blackbird have been recorded near but not in the project area (NDDB 1994). It is possible that this bird also occurs in other parts of the project area.

Project Impacts: The occurrences of tricolored blackbirds have been sufficiently distant from construction worksites to avoid direct impacts. Since the levees do receive some vehicular and foot traffic, it is unlikely that the blackbirds would choose to nest near the project levees. Therefore, no adverse impacts to tricolored blackbirds are anticipated.

Endangerment: Tricolored blackbirds are extremely sensitive to human activity. Foot traffic and vehicular traffic provide enough of a disruption to tricolored's to cause nesting dislocation. Loss of nesting sites and marsh habitat also threaten the tricolored blackbird (Sorenson 1992).

WHITE-FACED IBIS (*Plegadis chihi*)
Family: Threskiornithidae

Status: The white-faced ibis is a Category 2 Candidate for Federal listing. It has no State listing.

Description: The white-faced ibis is a dark, chestnut-colored bird with a long down-curved bill. This species is very similar to the glossy ibis of the eastern United States. The two can only be differentiated during the breeding season. During this time the white-faced ibis is characterized by white feathers bordering the bare facial skin, from the top of the bill around the eyes and under the chin. The glossy ibis has blue feathers bordering the bare facial skin (Terres 1980).

Habitat: The white-faced ibis seems to prefer freshwater marshes and rice fields where it eats insects, newts, leeches, earthworms, some snails, crustaceans, and fishes. Nesting occurs in colonies typically associated with wetlands; at times small groups may be found in heron rookeries. Nests are usually built in large beds of bulrushes or reeds (Terres, 1980).

Distribution: This species primarily occurs in central North America, east of the Sierra Nevada and west of the Mississippi River. Small breeding populations do occur in the Central Valley of California. Small numbers have been known to winter in southern central

California (Terres, 1980).

Project Area Occurrence: A search of the NDDB (1994) produced no sightings of the ibis in or near the project area. Suitable habitat as described does occur within the project area, and it is possible that this species may visit the area. However, it is very unlikely that any ibis nest in the project area.

Project Impacts: Adverse impacts are not anticipated because although ibises may pass through the area, they do not use it for wintering or nesting.

Endangerment: Endangerment stems from loss of habitat and eggshell thinning due to pesticide ingestion by the breeding birds.

E. Mammals

PACIFIC WESTERN BIG-EARED BAT (*Plecotus townsednii townsendii*)
Family: Vespertilionidae

Status: The Pacific western big-eared bat is a category 2 candidate for Federal listing. The State lists it as a Species of Special Concern.

Description: The Pacific western big-eared bats typically weigh 9 - 11 grams. Their forearms are 41 - 46 mm long and they have extremely large ears, over 25 mm high and joined at across the forehead. On the nose in front of the eyes are two prominent lumps. Generally, this bat is clove-brown, with the bases of ventral hairs being grey or brown and the tips brown or buffy. The tail membrane is naked and the skull has 32 teeth (Burt and Grossenheider 1980).

Habitat: The Pacific western big-eared bat requires caves, mines, tunnels, buildings, or other human-made structures for roosting. It may use separate sites for night, day, hibernation, or maternity roosts. Hibernation sites are cold but not below freezing. Maternity roosts are warm. Roosting sites are the most important limiting resource for this species. This bat prefers mesic sites. It captures beetles and a variety of soft-bodied insects in flight, or gleans them from brush or trees or feeds along habitat edges (Harris 1990).

Distribution: *P. t. townsendii* is found throughout California.

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. While this species may forage in the project area, no suitable roosting sites are present there.

Project Impacts: No adverse impacts to *P. t. townsendii* are anticipated since no roosting sites would be disturbed.

Endangerment: The primary threat to *P. t. townsensii* is habitat loss. This species is extremely sensitive to disturbance of roosting sites. All known nursery colonies in limestone caves in California have been abandoned. In addition, the species is especially sensitive to wing banding (Harris 1990).

GREATER WESTERN MASTIFF-BAT (*Eumops perotis californicus*)
Family: Molossidae

Status: The greater western mastiff-bat is a category 2 candidate for Federal listing. It has no State listing.

Description: The western mastiff bat is the largest native bat in the United States. Its wings are distinctively long and narrow. This allows rapid sustained flight, but limits maneuverability (Zeiner 1990).

Habitat: These bats live in arid and semi-arid lowlands. They roost on or in crevices, cliffs, trees, tunnels and buildings, usually in colonies but sometimes singly (Ingles, 1965). They use riparian habitat for forage (Zezulak, 1992). Suitable habitat for the bat consists of extensive open areas with abundant roost locations provided by crevices in rock outcroppings and buildings (Zeiner 1992).

Distribution: This species occurs in the lower Sonoran Desert, along the Colorado River and the California coast from San Diego to Santa Barbara and then in a narrow belt inland up to Alameda. They occur west of the confluence of the San Joaquin and Sacramento Rivers (Ingles 1965).

Project Area Occurrence: A search of the NDDB (1994) revealed no sightings of the bat in or near the project area. While this species may forage in the project area, no suitable roosting sites are present there.

Project Impacts: While suitable habitat does exist for this species in the Mid-Valley Area, potential nest sites for the bats would not be disturbed. Therefore, no adverse impacts to this bat are anticipated.

Endangerment: The loss of riparian habitat is a major endangerment to this species.

F. Invertebrates

SACRAMENTO VALLEY TIGER BEETLE (*Cicindela hirticollis abrupta*)
Family: Cicindelidae

Status: The Sacramento valley tiger beetle is a Federal Category 2 Candidate. It has no State listing.

Description: *C. h. abrupta* is a relatively recent subspecies thought to be derived from C. h. gravida (Graves 1989b). *C. h. abrubta* is between 1/3 - 2/3 in. in length and is a very dark, blackish-brown color. Its characteristics include long and slender legs, long, sickle-shaped mandibles, and head and eyes that together are wider than the thorax. Larva have been described for less then 10 percent of the species of the genus Cicindela (Pearson 1988).

Habitat: The Sacramento valley tiger beetle generally inhabits sandbar deposits along the rivers of the Sacramento Valley in California. The larvae inhabit burrows in the sand that constantly retain there moisture near the bottom (Graves 1988). The larvae tunnel is constructed with a funnel at the entrance where the larvae waits for prey to come within striking distance. Both larvae and adult are predators and will prey on a wide variety of arthropods. Adults may also scavenge on dead organisms (Pearson 1988).

Distribution: The Sacramento valley tiger beetle is currently located at three sites in Sutter County: Nicolaus, the Feather River, and the intersection of Highway 99 and the Feather River (Graves 1989a). None of these sites are in the study area.

Past county records include two locations where single specimens were discovered. The earliest sighting was in 1934 at Davis in Yolo County. The other specimen was unearthed by J.H. Robinson in 1950 in Sacramento County but no specific site data was given (Graves 1989a).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. Since there are no sandbar deposits which constantly retain moisture in the project area, the Sacramento Valley tiger beetle probably does not occur there.

Project Impacts: No adverse impacts to the Sacramento valley tiger beetle are anticipated since its habitat is not present in or near the proposed construction sites.

Endangerment: *C. h. abrupta* may face endangerment because of insecticides, agriculture, and alterations of their environment. Studies have shown dramatic declines in the abundant population of *C. hirticollis* along the Great Lakes because of its extreme sensitivity to human contact (Graves 1989b).

G. Plants

SUISUN ASTER (*Aster lentus* (*chilensis* var. *lentus*))
Family: Asteraceae

Status: The Suisun aster is a Category 2 Candidate for Federal listing. The State has no listing for this species. The CNPS categorizes the plant on their 1B list with a R-E-D code of 2-2-3; occurrence confined to several populations or one extended population; endangered in a portion of its range; and endemic to California (CNPS 1988).

Description: *A. lentus* is a robust, slightly succulent perennial with long rhizomes. Its erect stems are 4 - 15 dm tall and more or less glabrous. Leaves are basal and cauline, small and bract-like in inflorescence, sessil, 5 - 15 cm, linear to narrowly lanceolate, acute, and generally glabrous. The inflorescence heads are located at branch tips, in an open cyme. Phyllaries are linear to oblong, acute to more or less obtuse, and more or less pale-margined at their base. Ray flowers are numerous, corollas are violet and 8 - 14 mm long. Fruits are hairy. The flowering time for *A. lentus* is August to November (Hickman 1993, CNPS 1977).

Habitat: This species is found in tidal streams and among tules (*Scirpus* spp.) in marshy areas. It is often found in densely vegetated areas in stabilized substrate (USACE 1985, CNPS 1977).

Distribution: Historically, the Suisun has been recorded as occurring in Contra Costa, San Joaquin, Solano, Napa, and Sacramento Counties (CNPS 1988). The aster is currently found in the region from Suisun Marsh east to Jersey Island on the San Joaquin River and southeast to the Discovery Bay area. Recent sightings of the plant are mostly from the marshes around San Pablo Bay, the Suisun Marsh, and as far upstream as Toland's Landing just south of Rio Vista in Solano County, and along the San Joaquin River on Hog Island. Other sightings have been recorded in Contra Costa County on Brown's Island; in Sacramento County on Chain Island, and in Solano County in Barker Slough (DFG 1985 *in* USACE 1985).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. The Suisun aster is probably not found in the project area because it is out of the historic range of this species (Fuller 1994).

Project Impacts: No adverse impacts to Suisun aster are anticipated.

Endangerment: The primary threat to the Suisun aster is loss and alteration of habitat due to landfill, drainage of marshy habitat, pollution, and changes in salinity caused by water diversions (CNPS 1977).

FERRIS'S MILK-VETCH (*Astragalus tener* var. *ferrisiae*)
Family: Fabaceae

Status: Ferris's milk-vetch is a Category 2 Candidate for Federal listing. The State has no listing for this species. The CNPS categorizes the plant on their 1B list with a R-E-D code of 2-2-3; occurrence confined to several populations or one extended population; endangered in a portion of its range; and endemic to California (CNPS 1988).

Description: *A. t. ferrisiae* is a delicate, sparsely strigose to glabrous annual . Stems are erect or ascending and 6 - 26 cm long. Leaves are 2 - 6 cm long. The 7 - 15 leaflets are more or less well separated, 3 - 16 mm long, lanceolate to obovate, glabrous on upper surface, and the tips are notched or pointed. The inflorescence is dense, 3 - 12 flowered,

and spreading. Flower petals are pink-purple and the banner is 7.8 - 9.6 mm and recurved 35 - 40°. The keel is 4.2 - 5.1 mm long. The fruit is reflexed, 2.7 - 5.0 cm long, 1.7 - 3.5 mm wide, more or less narrowly lanceolate, strongly incurved, openly grooved on lower side, stiffly papery, and glabrous. The base is more or less stalk-like and 3 - 5 mm in length. Fruits have 2 chambers and approximately 10 - 16 seeds (Hickman 1993). The flowering period for this legume is from March to June (Munz and Keck 1968).

Habitat: Ferris's milk-vetch inhabits alkaline flats and vernally moist meadows at elevations less than 60 m (Hickman 1994, Liston 1989).

Distribution: There have been 7 known collections of Ferris's milk-vetch, mostly around the turn of the century, from Butte, Colusa, Solano, and Yolo Counties (Bitman 1992). The most recent collection was in Yolo County during 1978. No plants have been sited since 1978 (Liston 1990).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. Ferris's milk-vetch probably does not occur in the project area because no suitable habitat (alkaline flats or vernally moist meadows) is present there.

Project Impacts: No adverse impacts to Ferris's milk-vetch are anticipated because no suitable habitat for this species is present in the project area.

Endangerment: Ferris's milk-vetch is threatened by habitat loss.

ALKALI MILK-VETCH (*Astragalus tener* var. *tener*)
Family: Fabaceae

Status: The alkali milk-vetch is a Category 2 Candidate for Federal listing. The State has no listing for this species. The CNPS categorizes the plant on their 1B list with a R-E-D code of 3-2-3; occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported; endangered in a portion of its range; and endemic to California (CNPS 1988).

Description: *A. t. tener* is a delicate, sparsely strigose to glabrous annual . Stems are erect or ascending and 4 - 30 cm long. Leaves are 2 - 9 cm long. The 7 - 17 leaflets are more or less well separated, 3 - 16 mm long, lanceolate to obovate, glabrous on upper surface, and the tips are notched or pointed. The inflorescence is dense, 3 - 12 flowered, and spreading. Flower petals are pink-purple and the banner is 8.2 - 11.8 mm and recurved 35 - 40°. The keel is 4.7 - 6.4 mm long. The fruit is reflexed, 10 - 25 mm long, 1.7 - 3.5 mm wide, more or less narrowly lanceolate, more or less incurved, openly grooved on lower side, stiffly papery, and glabrous. The base is round, not stalk-like, and 3 - 5 mm in length. Fruits have 2 chambers and approximately 8 - 14 seeds (Hickman 1993). The flowering period for this legume is from March to June (Munz and Keck 1968).

Habitat: Alkali milk-vetch inhabits alkaline flats and vernally moist meadows at elevations less than 60 m (Hickman 1994, Liston 1989).

Distribution: Alkali milk-vetch was once found from the Salinas Valley north to the Sacramento Valley and was quite common on the alkaline flats surrounding San Francisco Bay. Currently, this plant can be found at two general locations: Jepson Prairie Preserve and the City of Woodland property at County Roads 25 and 103 (Witham 1990).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. Alkali milk-vetch probably does not occur in the project area because no suitable habitat (alkaline flats or vernally moist meadows) is present there.

Project Impacts: No adverse impacts to alkali milk-vetch are anticipated because no suitable for this species is present in or near the project area.

Endangerment: Alkali milk-vetch is threatened by habitat loss.

VALLEY SPEARSCALE (*Atriplex joaquiniana*)
Family: Chenopodiaceae

Status: Valley spearscale is a Category 2 Candidate for Federal listing. The State has no listing for this species. The CNPS categorizes the plant on their 1B list with a R-E-D code of 2-2-3; occurrence confined to several populations or one extended population; endangered in a portion of its range; and endemic to California.

Description: *Atriplex joaquiniana* is a monoecious annual which varies from 1 - 10 dm high. Stems are erect and have many spreading to ascending branches. Twigs are densely fine-scaly, and become glabrous. Leaves are arranged alternately about the branches. Leaf blades are 10 - 70 mm., ovate to triangular, finely gray-scaly or green above, and generally irregularly wavy-toothed. The leaf base is truncate to tapered. The upper leaves are abruptly reduced. The staminate inflorescence is spike or panicle-like, terminal, and dense. Each flower has 3-5 calyx lobes and 3-5 stamens. The pistillate inflorescence is spike or panicle-like. While in fruit, the bracts of the pistilate inflorescence are 3 - 4 mm, fused below the middle, more or less round-deltate, ribbed, and entire. The seeds are approximately 1 - 1.5 mm in diameter, erect, and dark brown (Hickman 1993). Flowering time for this plant is April to September (Munz and Keck 1968).

Habitat: Valley spearscale inhabits alkaline soils at elevations less than 100 m (Hickman 1993).

Distribution: Valley spearscale occurs in scattered populations in the southern Sacramento Valley, San Joaquin Valley, and the east slope of the Inner South Coast Range (Hickman 1993).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. *A. joaquiniana* probably does not occur in the project area because no suitable habitat (alkaline flats) is present there.

Project Impacts: No adverse impacts to valley spearscale are anticipated because no suitable for this species is present in or near the project area.

Endangerment: *A. joaquiniana* is threatened by habitat loss.

HISPID BIRD'S-BEAK (*Cordylanthus mollis* ssp. *hispidus*)
Family: Scrophulariaceae

Status: Hispid bird's-beak is a Category 2 Candidate for Federal listing. It has no State listing. In addition, hispid bird's-beak is on the CNPS's 1B list and has a R-E-D code of 2-3-3; occurrence confined to several populations or one extended population; endangered throughout its range; and endemic to California (CNPS 1988).

Description: *C. m. hispidus* is a facultative hemi-parasitic annual. The plants are generally 10 - 40 cm, gray-green, often tinged purple, glandular-puberulent and long-nonglanded hairy. Stems are branched many times from near their base and are spreading. Leaves are 10 - 25 mm, more or less oblong, and entire to 7-lobed. Inflorescence is a spike, 20 - 60 mm, with leaf-like outer bracts. Inner bracts are 15 - 25 mm and more or less pinnately 3 - 7-lobed. Flowers are composed of a 15 - 20 mm calyx and a 15 - 20 mm corolla. Corollas are whitish, sparsely tomentose, and the middle lobe of the lower lip is erect. Flowers have two fertile stamens, 2 anther sacs and a glaborous style. Each flower produces 20 - 30 seeds, each being 1 - 1.5 mm, more or less reniform, deeply netted, and dark brown (Hickman 1993). Flowering time is from June to November (Chuang and Heckard 1973).

Habitat: Hispid bird's-beak inhabits saline marshes and flats at elevations less than 10 m. It is typically associated with salt grass (*Distichlis* spp.) (Chuang and Heckard 1973, Hickman 1993).

Distribution: Hispid bird's-beak is limited to the Central Valley of California in Solano Merced, and Kern Counties (Chuang and Heckard 1973, Hickman 1993).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of hispid bird's-beak in or near the project area. No habitat for this species (saline marshes and flats) is present in the project area.

Project Impacts: Since its habitat would not be affected by the proposed project, no adverse impacts to hispid bird's-beak are anticipated (Fuller 1994).

Endangerment: Hispid bird's-beak is threatened by habitat loss and fragmentation due to agricultural development.

RECURVED LARKSPUR (*Delphinium recurvatum*)
Family: Ranunculaceae

Status: The recurved larkspur is a category 2 candidate for Federal listing. The State has no special classification for this species. The CNPS places this species on their 1B list with a R-E-D code of 1-2-3; rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low at this time; endangered in a portion of its range; endemic to California (CNPS 1988).

Description: *D. recurvatum* is a perennial with 18 - 85 cm stems. The stem base is often narrower than root but firmly attached to root and the stems are more or less glaborous. Leaves are 3 - 11 lobed and more or less glaborous. Basal leaves are generally much larger than cauline leaves. Pedicles are 10 - 56 mm, 7 - 25 mm apart, and more or less glaborous. Sepals are generally light blue and reflexed. Laterals are 11 - 16 mm and the spur is 10 - 18 mm. The lower petals are white. The fruit is 8 - 21 mm, generally less than 3X longer than wide. Seeds are winged and coat cell margins are wavy (Hickman 1993). Flowering time is March to May (Munz and Keck 1968).

Habitat: Recurved larkspur inhabits poorly drained, fine, alkaline soils in grasslands and *Atriplex* scrub from 30 - 600 m in elevation (Hickman 1993).

Distribution: D. recurvatum is found in Glenn and Butte Counties and from Contra Costa County south to Kern County (CNPS 1988, Munz 1968).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area.

Project Impacts: Since its habitat (poorly drained alkaline soils in grasslands) would not be affected by the proposed project, no adverse impacts to hispid bird's-beak are anticipated (Fuller 1994).

Endangerment: Threats to this species stem from the continued loss of habitat due to the development of agricultural lands. Some populations are threatened by a proposed reservoir (CNPS 1988).

FRAGRANT FRITILLARY (*Fritillaria liliacea*)
Family: Liliaceae

Status: Fragrant fritillary is a category 2 Candidate for Federal listing. It has no special status with the State. The CNPS places this species on their 1B list with a R-E-D code of 1-2-3; rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low at this time; endangered in a portion of its range; endemic to California (CNPS 1988).

Description: *F. liliacea* is a bulbed perennial. The bulb has 2 - 7 large scales and 1 - 2 small scales. The stem is 1 - 3.5 dm, simple and erect. The 2 - 20 leaves are alternate, 3.5 - 12 cm, and linear to ovate. The inflorescence is a raceme and the bracts are leaf-like. Flowers are nodding, bell- or -cup shaped, orderless or sweet-scented. The perianth consists of 6 segments of 2 similar whorls. Perianth parts are 1-1.6 cm, white, and striped green. The 6 nectaries are 1/2 - 2/3 the perianth length, narrowly linear, and purplish to greenish. The six stamens are inserted at the perianth base, anthers are attached more or less near the middle. The ovary is more or less sessile and the style is divided in half. The fruit is a obtusely angled loculicidal capsule (Hickman 1993).

Habitat: Fragrant fritillary inhabits heavy soils in open fields and hills near the coast. It grows at elevations less than or equal to 200 m (Hickman 1993, CNPS 1988).

Distribution: Fragrant fritillary is limited to central western California (Hickman 1993, CNPS 1988).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of fragrant fritillary in or near the project area. Nevertheless, this species could be present undetected (Fuller 1994). If this lily is listed before the project is constructed, surveys would be conducted to determine its presence in the project area.

Project Impacts: If this species is listed and surveys reveal its presence in the project area, Section 7 consultation would be initiated with the FWS to determine appropriate mitigation measures, and a supplemental BA would be prepared.

Endangerment: Fragrant fritillary is threatened by habitat loss and fragmentation (CNPS 1988).

ADOBE LILY (*Fritillaria pluriflora*)
Family: Liliaceae

Status: The adobe lily is a Category 2 Candidate for Federal listing. It has no special status with the State. The CNPS places this species on their 1B list with a R-E-D code of 1-2-3; rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low at this time; endangered in a portion of its range; endemic to California (CNPS 1988).

Description: *F. pluriflora* is a bulbed perennial. The bulb has 1 - 12 large scales and 0 - 2 small scales. The stem is 1.5 - 4.5 dm, simple and erect. The 3 - 10 leaves are alternate, clustered near the ground, 6 - 15 cm, and elliptic to obovate-oblong. Flowers are nodding. Perianth parts are 2 - 3.5 cm, obovate, pinkish purple, and the tips are rounded to acute. The nectary is 2/3 the perianth length, narrowly linear, and lavender. The six stamens are inserted at the perianth base, and the anthers are attached more or less near the middle. The ovary is more or less sessile and the style is entire. The fruit is a obtusely angled loculicidal

capsule (Hickman 1993).

Habitat: Adobe lily inhabits chaparral, cismontane woodland, and valley foothills and grasslands, often on adobe soils. It is found at elevations less than or equal to 500 m (CNPS 1988. Hickman 1993).

Distribution: The adobe lily is found in the inner north Coast Ranges, the northern Sierra Nevada foothills, the edges of the Sacramento Valley, and southern Oregon (Hickman 1993).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in or near the project area. Nevertheless, this species could be present undetected (Fuller 1994). If this plant is listed before the project is constructed, surveys would be conducted to determine its presence in the project area.

Project Impacts: If this species is listed and surveys reveal its presence in the project area, Section 7 consultation would be initiated with the FWS to determine appropriate mitigation measures, and a supplemental BA would be prepared.

Endangerment: This species is threatened by grazing, off-road vehicles, and horticultural collecting (CNPS 1988).

DELTA TULE-PEA (*Lathyrus jepsonii* ssp. *jepsonii*)
Family: Fabaceae

Status: The Delta tule pea is a Federal Category 2 Candidate species. The State has no special status for this taxon. The CNPS categorizes the plant on their 1B list with a R-E-D code of 2-2-3; occurrence confined to several populations or one extended population; endangered in a portion of its range; and endemic to California (CNPS 1988).

Description: *L. j. jepsonii* is a glabrous, often robust vine-like perennial. Stems are less than 2.5 m, climbing, and winged. Leaves are evenly 1-pinnate. Stipules are small, generally narrow, and persistent. There are 10 - 16 leaflets, each being 3.5 - 5.5 cm in length, linear to lanceolate in shape, and arranged subopposite to alternate. The leaf's main axis ends as a branched, coiled tendril. The inflorescence is a raceme, generally axillary, and 6 - 15 flowered. The calyx tube is greater than or equal to the upper lobes and approximately equal to the lower lobes. The corolla is 15 - 20 mm and generally pink to pink-purple. Nine of the filaments are fused and one is free. The style is flat and finely hairy on the concave side. The fruit is glabrous, dehiscent, oblong, and more or less flat. Flowering time is May to June (Hickman 1993, Munz and Keck 1959).

Habitat: *L. j. jepsonii* is found in intertidal and freshwater wetlands such as tule marshes, muddy riverbanks, brackish and freshwater sloughs, and rarely on older vegetated riprapped banks. Occasionally, it is found on drier ground in well-established riparian habitat, or as individual plants climbing up tall emergent vegetation such as tules (*Scirpus* spp.) and cattails

(*Typha* spp.), hence its common name (Munz 1959, Jepson 1925 *in* USACE 1985).

Distribution: Historically, Delta tule pea has been recorded as occurring in Alameda, Contra Costa, Fresno, Napa, San Benito, Santa Clara, Solano, and San Joaquin Counties (CNPS 1988). According to recent sightings, *L. j. jepsonii* is distributed primarily along the riparian fringes of the islands in the lower Sacramento-San Joaquin Delta and the Suisun marshes (Harvey and Stanley 1984, DiVittorio 1985 *in* USACE 1985)

Project Area Occurrence: A search of the NDDB revealed no occurrences in or near the project area. Since no habitat for this species is present in the project area, it probably does not occur there.

Project Impacts: Since its habitat would not be affected by the proposed project, no adverse impacts to Delta tule pea are anticipated (Fuller 1994).

Endangerment: Reasons for the past decline of *L. j. jepsonii* are not known. However, the most likely threats to the taxon's continued existence are changes in the salinity of the marsh waters, or in the drainage of the marshes which may adversely affect or destroy habitat. (USACE 1985).

LEGENERE (*Legenere limosa*)
Family: Asteraceae

Status: This taxon is a Category 2 Candidate currently under review for listing as endangered or threatened. However, currently it has no special status under State laws. *L. limosa* is on the CNPS's 1B list and has a R-E-D code of 2-3-3; occurrence confined to several populations or one extended population; endangered throughout its range; and endemic to California (CNPS 1988).

Description: *L. limosa* is a glabrous emergent or terrestrial annual. The stem is 10 - 30 cm long and reclining. Lateral branches are erect, slender, stiff, and sometimes fleshy. Leaves are cauline, narrowly triangular, entire, sessile, and early deciduous. The inflorescence is a terminal raceme and its axis follows more or less a zig-zag pattern. Each flower has one 6 - 12 mm, ovate, leaf-like bract which is spreading. Pedicels are 6 - 20 mm in fruit. Sepals are triangular and 1/3 to 1/2 times the size of the ovary. The corolla is white and sometimes absent in lower flowers. Its tube is about 1.5 mm, linear, and split down the back more or less to the base. The corolla is 2-lipped, with the upper lip being 2-lobed (lobes are about 2 mm, narrow and erect). The lower lip is 3-lobed, each approximately 2 mm and obovate. The stamens are fused into the tube. Anthers are 0.5 - 1 mm, sometimes free with age, and the two shorter anthers are minutely appendaged. The ovary is inferior, about 3.5 mm, and narrowly obconic. The stigma is head-like and smooth. The fruit is 6 - 10 mm long, 1 - 2 mm in diameter, cylindric, 1-chambered, slightly greater than the hypanthium, and the tip is rounded and dehiscing. Seeds are 1 mm, elliptic, shiny, and chestnut-brown (Hickman 1993). Flowering time is from May to June (CNPS 1977.)

Habitat: *L. limosa* inhabits the beds of vernal pools and swales. Vernal pools are shallow depressions in the soil surface underlain by some impervious substratum that blocks the downward percolation of rainwater, resulting in a pool of water which lasts more or less throughout the rainy season and drys completely during the hot, rainless summer. Species commonly associated with *L. limosa* include *Lasthenia glaberrima, Allocarya stipitata* var. *micrantha, Gratiola ebracteata, Downingia bicornuta, D. ornatissima, Orthocarpus campestris, Eleocharis macrostachya*, and *Eryngium vaseyi* (Holland 1983).

Distribution: Historically, *L. limosa* was found in Lake, Napa, Placer, Sacramento, San Mateo, Solano, Sonoma, and Stanislaus Counties. However, many of the populations representing these occurrences have been extirpated (CNPS 1988).

Project Area Occurrence: A search of the NDDB revealed no occurrences in or near the project area. Since no habitat for this species (vernal pools) is present in the project area, it probably does not occur there.

Project Impacts: Since its habitat would not be affected by the proposed project, no adverse impacts to legenere are anticipated (Fuller 1994).

Endangerment: *L. limosa* is endangered throughout its range due to loss of habitat caused by land grading, plowing, draining of vernal pools, pollution of waterways, and heavy grazing (CNPS 1977).

MASON'S LILAEOPSIS (*Lilaeopsis masonii*)
Family: Apiaceae

Status: *L. masonii* is a Category 2 candidate for Federal listing. The State categorizes it as rare. The CNPS categorizes the plant on their 1B list with a R-E-D code of 2-2-3; occurrence confined to several populations or one extended population; endangered in a portion of its range; and endemic to California (CNPS 1988).

Description: *L. masonii* is a glabrous rhizotamous perennial that forms a low turf. Stems are prostrate and creeping. Its leaves are mostly tufted at tips of vertical branches, 1.5 - 7.5 cm long, 0.4 - 1.2 mm wide, linear or thread-like, and lack a definite blade or petiole. The inflorescence is a simple, open, peduncled umbel with several inconspicuous bracts and a few spreading to recurved pedicels. The peduncles are 2 - 20 mm long; bracts are 0.5 - 1 mm long; and the 3 - 8 pedicels are 1 - 6 mm long. The fruit is 1.2 - 1.6 mm long, elliptic or ovate, corky-thickened, and with only marginal ribs rounded. There are 5 - 6 oil tubes per rib-interval (Hickman 1993, Mathias and Constance 1977). Plants flower from April to October (Affolter 1985).

Habitat: *L. masonii* occurs on the margins of rivers, banks, sloughs, and islands. It tends to form a sod at the edge of the water where it is frequently inundated by waves and tidal fluctuation. The plant generally grows in soils high in clay, on stable shoreline mudflats, on

semi-stabilized substrate such as partially buried logs with debris and soil deposited in cracks, and on clay deposits over sandy substrate. *L. masonii* is found in association with bulrush (*Scirpus* spp.), horsetail (*Equisetum* spp.), marsh pennywort (*Hydrocotyl verticillata*), arrow grass (*Triglochin striata*), and Suisun aster (*Aster chilensis* var. *lentus*) (USACE 1985, Mathias and Constance 1977).

Distribution: Past record on the plant are few and the historic range is not well known (USACE 1985). Sightings have occurred in deltaic regions of Contra Costa, Solano, Sacramento, and San Joaquin Counties and along the Napa River in Napa County.

Project Area Occurrence: A search of the NDDB revealed no occurrences of Mason's lilaeopsis in or near the project area. Since no habitat for this species (deltaic tidal wetlands) is present in the project area, it probably does not occur there.

Project Impacts: Since its habitat would not be affected by the proposed project, no adverse impacts to legenere are anticipated (Fuller 1994).

Endangerment: This species is threatened by Delta flood control projects, the widening of Delta channels, dredging and dumping of soils, recreation development, and water quality changes from decreased flows in the Delta.

VEINY MONARDELLA (*Monardella douglasii* ssp. *venosa*)
Family: Lamiaceaeae

Status: The veiny monardella is Federally listed as a Category 2 Candidate species. It has no State listing.

Description: *Monardella douglasii* var. *venosa* is a finely pubescent erect annual herbaceous plant, simple or branched, 1 to 3 dm. high with a pleasant odor. Flowers of this monardella are borne on terminal flower heads that are 1 to 1.5 cm broad with broadly ovate, acuminate, translucent bracts 15 to 18 mm long that have purple veins. The calyx is narrow and tubular, about 7 to 9 mm long and pubescent to rough with shaggy hairs. Petals are reddish-purple, the upper lip erect and 2 lobed, the lower 3-lobed and horizontal, with some lobes terminating in glands. Leaves are lanceolate to narrow-oblong, 1 to 3 cm long, strigose and short-petioled. Flowering time is June to July (Munz 1973).

Habitat: This species is found in valley and foothill grasslands with introduced, annual Mediterranean grasses and native herbs. On most sites the native species, such as needle grass, have been largely or entirely supplanted by introductions. Stands rich in natives are usually found on unusual substrates, such as serpentine or somewhat alkaline soils (CNPS 1988, Munz 1973).

Distribution: Historical collections of veiny monardella are known from Butte, Sutter, Tuolumne and possibly Plumas Counties. Two of these populations were located in Butte

County, on Cherokee and Chico Quadrangles (CNPS 1988).

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of veiny monardella in or near the project area. Nevertheless, this species could be present undetected (Fuller 1994). If this plant is listed before the project is constructed, surveys would be conducted to determine its presence in the project area.

Project Impacts: If this species is listed and surveys reveal its presence in the project area, Section 7 consultation would be initiated with the FWS to determine appropriate mitigation measures, and a supplemental BA would be prepared.

Endangerment: The primary threat to this species is habitat loss.

SHOWY INDIAN CLOVER (*Trifolium amoenum*)
Family: Fabaceae

Status: *T. amoenum* is a Category 2 Candidate for Federal listing. The State has no listing for the plant.

Description: *T. amoneum* is a robust, hairy annual with erect stems, cauline leaves, and conspicuous stipules. Its leaves are widely obovate. The inflorence is an ovoid to spheric head. The calyx is 10-12 mm long, slender, and plumose. The corolla is 12-16 mm long, purple, and white-tipped. The ovary produces 1 - 2 seeds (Hickman 1993). The flowering time for this clover is between April and early June (CNPS 1988).

Habitat: Showy Indian clover inhabits grasslands with moist, heavy soils, often in disturbed areas at elevations less than 100 m (Hickman 1993).

Distribution: Historically, this clover was found in Alameda, Mendocino, Marin, Napa, Santa Clara, Solano, and Sonoma Counties (CNPS 1988). Currently, only one individual is known to exist.

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences of showy Indian clover in or near the project area. The project area is out of the known historic range of this species so it probably does not occur there (Fuller 1994).

Project Impacts: No adverse impacts to showy Indian clover are anticipated.

Endangerment: *T. amoneum* is highly edible to livestock and has been totally eliminated from areas where grazing occurs. Habitat loss through intensive agriculture and urban development has also been detrimental to this species (CNPS 1977).

3.4 State Listed Species

BANK SWALLOW (*Riparia riparia*)
Family: Hirundinidae

Status: The bank swallow is considered threatened by the State of California. It has no Federal listing.

Description: The bank swallow is a small bird, 4.75 - 5.5 inches long with a wingspread of 10-11 inches. Both the male and female are outwardly alike with a brown back and white underparts. There is a brown band across the white breast just below the throat and the tail is slightly forked. In flight the bird twists and turns in an erratic zigzag pattern (Terres 1980).

Habitat: The bank swallow is generally considered a riverain riparian species; however, it also breeds near lakes, coastal bluffs, and in some areas away from water. It nests colonially in earthen banks and bluffs, and in sand and gravel pits. Bank swallow nesting habitat consists of eroding banks with the top section of the bank characterized by vertical walls of fine sandy loam soil. Bank exposure ranges from north to east on the Sacramento River. Most colonies are near open grass fields (USACE 1987).

Distribution: Historically, the bank swallow was a common resident of the Sacramento River banks. Due to little historical data it is difficult to determine how much of a population change has taken place. Bank swallows have been completely extirpated from southern California. The majority of the population that remains in California is now centered in the Sacramento Valley along the Sacramento and Feather rivers. There have been documented losses of colony sites on the Sacramento River since 1975 due to riprap installation (DFG 1987).

Project Area Occurrence: A search of the NDDB (1994) revealed three occurrences near the project area.

Project Impacts: No adverse impacts to the bank swallow or its habitat are anticipated. Construction activities would be confined to the crown and landside of levees. Waterside work would be avoided.

Endangerment: Inland channelization of rivers, erosion control, and bank stabilization programs have destroyed former nesting sites. Channelization is the most insidious, long term threat to this species. Planned bank protection projects along the Sacramento River will destroy almost all of the existing colonies. Harassment by humans is another endangerment factor (DFG 1978).

SWAINSON'S HAWK (*Buteo swainsoni*)
Family: Accipitridae

Status: The Swainson's hawk is a State-listed threatened species and a category 2 candidate species for Federal listing.

Description: The wing span of the Swainson's hawk is 4 - 4.75 ft. The wings are slightly pointed, and when gliding are held in a somewhat above horizontal position. Both sexes of this hawk are similar in appearance. Typical adults can be identified by the dark breastband. From overhead, buffy wing-linings contrast with the dark flight feathers and the tail is gray above, often shading to white at the base (Peterson 1961).

Habitat: The Swainson's hawk is primarily found in riparian habitats. Cottonwoods, oaks, sycamores, and large willow trees form the dominant overstory vegetation in the zones most important to Swainson's Hawks. Historically, and to a lesser extent today, a native grassland community, including oat, bromegrass, ryegrass, barley, and ryegrass provided foraging habitat for Swainson's Hawks beyond the valley oak component of the riparian system (Warner 1984).

Nests are built at the top of cottonwoods and oaks that provide shade for the nest and also afford a good view of the surrounding terrain. Nests are generally 3 to 4 ft. across and up to 100 ft. above the ground. The same nest is often repaired and used again and again (Warner 1984).

Food consists almost entirely of injured rodents and insects: locusts, crickets, and ground squirrels. Suitable foraging habitats include native grasslands or lightly grazed pastures, alfalfa, other hay crops, and certain grain and row crops (Terres 1980).

Distribution: Historically, the range of the Swainson's Hawk included most of California except the Sierra Nevada and the wet northwest portion of the state. This hawk was once found throughout lowland Canada but is now restricted to portions of the Central Valley and Great Basin regions (DFG 1979). The Statewide population is estimated at only 550 pairs.

Today, the Swainson's hawk is limited to the Central Valley and portions of the extreme northeastern part of the state. This species is a scarce breeding bird in the State of California, having suffered the most severe decline of any bird in the State except for the Bell's Vireo. Most reports of birds in the northeastern part of the state refer to migrants. Only a few pairs remain in the San Joaquin Valley, and most of these are from Merced County and northward. The largest known population remaining is located in the Davis-Woodland-Sacramento area of the Sacramento Valley where five to six nests have been reported (DFG 1978).

Project Area Occurrence: A search of the NDDB (1994) revealed eight occurrences in and near the project area. Swainson's hawk has been known to breed and forage throughout the project area. Several hawks were sighted by Corps and FWS personnel at different project sights during field visits. One hawk at Site 12a was observed behaving as if a nest was nearby, although no nest was sighted.

Project Impacts: Project construction could adversely affect Swainson's hawks by destroying their habitat. In addition, construction activities may disturb any nearby hawks. Direct impacts to hawks could be avoided if construction activities are prohibited within one-half mile of nest sites until after the young have fledged. In addition, any trees with nests should be avoided.

Endangerment: Endangerment threats stem from loss of habitat due to urban expansion into existing agricultural and grassland areas and from the trend toward planting more and more crops that are unsuitable for Swainson's hawks (vineyards, orchards, rice, corn, and cotton).

YELLOW-BILLED CUCKOO (*Coccyzus americanus*)
Family: Cuculidae

Status: The yellow-billed cuckoo is a State-listed endangered species. It has no Federal listing.

Description: The yellow-billed cuckoo is 11 to 12.5 inches long with a wingspan of 15.5 to 17 inches. It is a slender bird, grayish brown above and white below, with rufous (yellowish red) color on the wings. White spots on black undersurface of the tail are larger and more conspicuous than those of the black-billed cuckoo. The lower mandible is yellow. Both sexes are outwardly alike in appearance (Terres 1980).

Habitat: The yellow-billed cuckoo prefers thickets of willow and cottonwood with dense understory vegetation of woody or herbaceous plants or shrubs. Cuckoos most frequently occur where extensive riparian vegetation is interspersed with sloughs, lakes, and/or marshy areas (USACE 1987). Twenty five acres of habitat are required to support one nesting pair of cuckoos. Cuckoos forage primarily for large insect prey, including caterpillars, beetles, grasshoppers, tree crickets, army ants, and wasps, at all canopy levels (especially in cottonwoods and willows) (Terres 1980).

The large home range size and the preference for cottonwoods for foraging explain why most riparian habitats do not afford summer homes to cuckoos. Most riparian habitats in California are either dominated by willows and/or are narrow strips or isolated patches (Laymon 1986).

All nesting occurs in riparian woodland. Nesting is most common in willow trees. Nest height has been found to be 2 to 12 feet above ground. Nesting occurs between March and August in the southern part of the range (Terres 1980).

Distribution: The western subspecies of the yellow-billed cuckoo breeds from western Texas, south into Sonora, Mexico and west into California. Historically, they bred north to British Columbia, Canada, but in recent years Red Bluff on the Sacramento River is the farthest north that they are found (Laymon 1986). In California the bird was common in every county in the Sacramento region with the exception of Placer. Breeding has been verified in Tehama, Butte, Glenn, Colusa, and Yolo Counties. Early reports suggest that the cuckoo was numerous along most of the wooded streams and sloughs of the Sacramento Valley. Nesting was common in willow and cottonwood forests throughout the state. At least one pair nested in the Sacramento Bypass in 1952, and individuals were recorded from this and adjacent areas from 1956 to 1965. None have been found there since (Gaines and Laymon 1984).

A 1972-73 survey estimated the cuckoo population of the Sacramento River at 60 pairs. Surveys conducted along the Sacramento River in 1977 estimate the population at 15 pairs and 14 solitary birds. Of these 44, none occur south of Colusa on the Sacramento River or in the Delta (Gaines and Laymon 1984), since riparian vegetation suitable for cuckoos is severely limited along the Sacramento River south of Colusa and in the Delta (USACE 1987).

At present, the western yellow-billed cuckoos occur in six widely separated parts of the State--in the Sacramento Valley in Tehama, Butte, Glenn, Colusa, and Sutter Counties; along the South Fork Kern River in Kern County; along the Santa Ana River in Riverside County; in Owens Valley, Inyo County; along the Amargosa River south of Tecopa in Inyo and San Bernadino Counties; and along the Colorado River between the Nevada line and the Mexican border (Gaines Laymon 1984). Current distribution in the State of California has diminished from 122 to 163 pairs estimated statewide in 1977 to only 31 to 42 pairs estimated in 1986-1987.

Project Area Occurrence: A search of the NDDB (1994) revealed no occurrences in the project area. The nearest historic sighting was in the Sacramento Bypass at the extreme southern end of the project. Cuckoos probably do not occur in the project area because the riparian forest is composed of thin strips and patches which are not suitable habitat for this species.

Project Impacts: No adverse impacts to the yellow-billed cuckoo are anticipated.

Endangerment: Endangerment stems from urban and agricultural expansion into select habitats for the yellow-billed cuckoo. Clearing of forests and loss of riparian habitat for flood control and expansion have caused a decrease in the population of cuckoos (FWS 1985).

4.0 Summary and Recommendations

4.1 Overview

Of the 13 Federally listed species, one is know to occur in the Phase III project area (VELB), one is probably in the project area (giant garter snake), and three may occasionally visit the project area (bald eagle, Aleutian Canada goose, and American peregrine falcon). Two of the species occur near but not in the project area (winter-run chinook salmon and delta smelt), and six species do not likely occur in or near the project area (vernal pool tadpole shrimp, vernal pool fairy shrimp, conservancy fairy shrimp, delta green ground beetle, palmate-bracted bird's-beak, and Solano grass). Of the three State-listed species, one occurs in the project area (Swainson's hawk), one is found very near but not in the area (bank swallow), and one probably does not occur in or near the project area (western yellow-billed cuckoo).

4.2 Impacts of Proposed Project

About 8.24 acres of riparian woodland, 3.22 acres of scrub-shrub, 13.08 acres of emergent marsh, 0.05 acre of permanent wetland, and 199.69 acres of annual grassland and agricultural lands would be affected by the proposed project. In addition, 73 individual trees would be lost.

4.3 Recommendations

1. Loss of the VELB and its habitat should be mitigated in accordance with current FWS guidelines (Appendix B). Some shrubs located in the project area and construction right-of-way could be avoided. These shrubs should be fenced off prior to construction.

2. If bald eagles are sighted, construction activities should be restricted along the Sacramento River between March and October to avoid impacts to the eagle.

3. To avoid disturbing the State-listed Swainson's hawk, construction should not be allowed within a 1/2-mile radius of any occupied Swainson's hawk nest until after the young have fledged.

4. Giant garter snakes may be present in irrigation ditches and ponds which might be affected by the proposed project. In areas where adverse effects are significant and cannot be avoided, a cutoff wall through the levee crown could be constructed instead of filling the irrigation ditch. A pre-construction survey for the giant garter snake should be conducted in the spring of 1995 in accordance with FWS and DFG guidelines. If giant garter snakes are found or suspected, in-kind habitat replacement would be required. In addition, construction activities in habitat areas would be prohibited during the winter dormant period (November through March) when snakes are inactive below ground and unable to flee humans and machinery.

5. A rare plant survey should be conducted during the spring of 1996 to determine if any of the proposed species with potential habitat in the project area are present. It is likely that one or more of these plants may be listed before the project is constructed.

6. Prior to construction a survey for the bank swallow would be conducted in the spring of 1995 in accordance with DFG guidlines.

5.0 Coordination

Both informal and formal coordination with the FWS, NMFS, and DFG has been maintained throughout the preparation of the biological data report. The Corps retrieved a listing of State-listed threatened and endangered species from the NDDB (1994). The Corps received a list of threatened and endangered species and other species of concern from FWS in April 1995. In addition, various experts from these three agencies were contacted regarding questions of distribution of and potential impacts to special status species.

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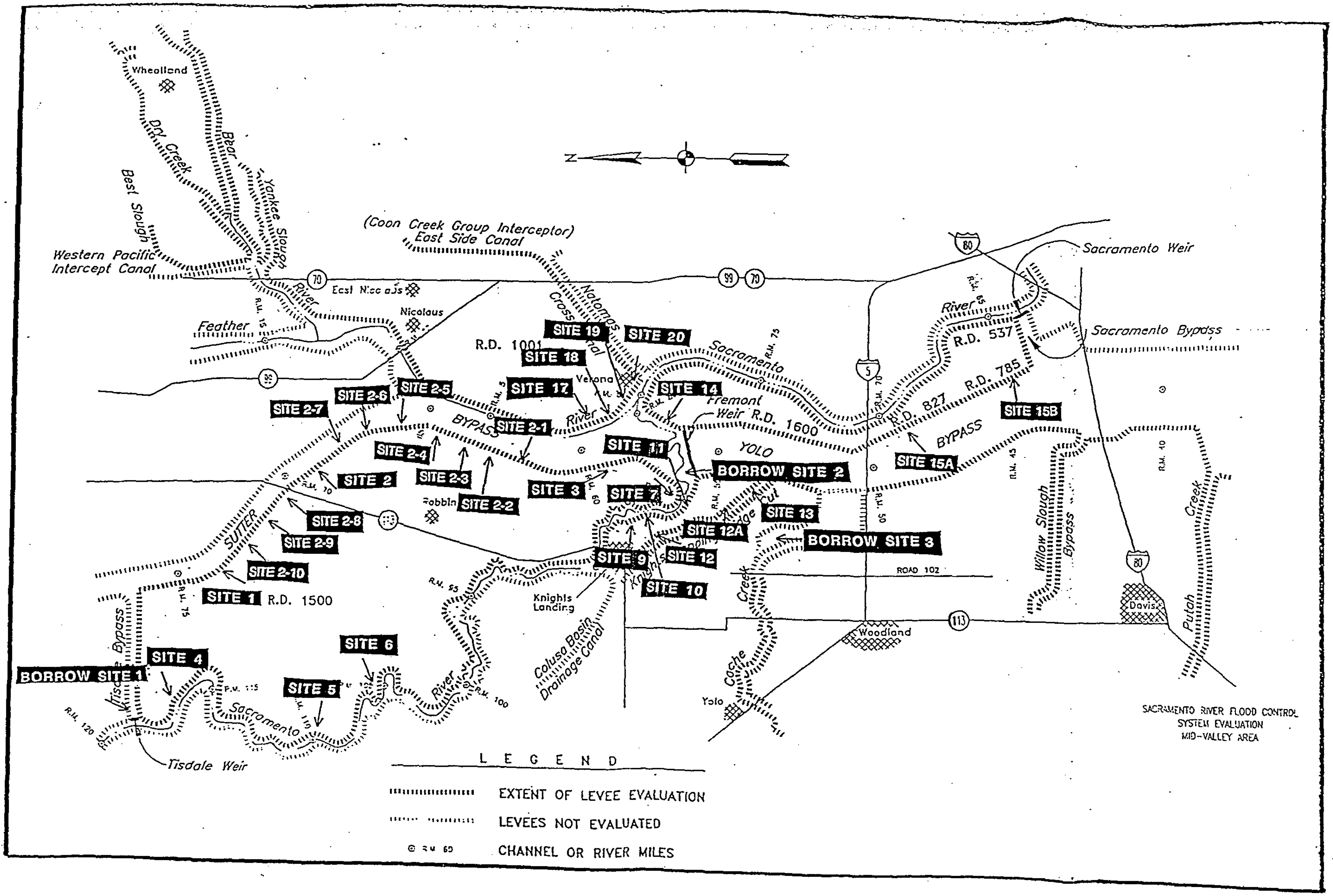


Plate 1 General site locations of the proposed remedial repairs and borrow sites for the Sacramento River Flood Control System Evaluation, Phase III project (USACE 1991).

Appendix

Updated Species List for the Sacramento River Flood Control Systems Evaluation, Phase III, Sacramento County, California

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
Sacramento Field Office
2800 Cottage Way, Room E-1803
Sacramento, California 95825-1846

IN REPLY REFER TO:

1-1-95-SP-647

April 18, 1995

Mr. Mark Pelz
Department of the Army
U.S. Army Engineer District, Sacramento
Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: Updated Species List for the Sacramento River Flood Control Systems Evaluation, Phase III, Sacramento County, California

Dear Mr. Pells:

As requested by your telephone call of March 9, 1995, you will find enclosed an updated list of the listed, proposed, and/or candidate species that may be present in or may be affected by projects in the subject project area (see Enclosure A). This list fulfills the requirement of the Fish and Wildlife Service (Service) to provide a species list pursuant to section 7(c) of the Endangered Species Act, as amended (Act).

Some pertinent information concerning the distribution, life history, habitat requirements, and published references for the listed species is also enclosed. This information may be helpful in preparing the biological assessment for this project, if one is required. Please see Enclosure B for a discussion of the responsibilities Federal agencies have under section 7(c) of the Act and the conditions under which a biological assessment must be prepared by the lead Federal agency or its designated non-Federal representative.

Formal consultation, pursuant to 50 CFR § 402.14, should be initiated if you determine that a listed species may be affected by the proposed project. If you determine that a proposed species may be adversely affected, you should consider requesting a conference with our office pursuant to 50 CFR § 402.10. Informal consultation may be utilized prior to a written request for formal consultation to exchange information and resolve conflicts with respect to a listed species. If a biological assessment is required, and it is not initiated within 90 days of your receipt of this letter, you should informally verify the accuracy of this list with our office.

Candidate species are currently being reviewed by the Service and are under consideration for possible listing as endangered or threatened. Candidate species have no protection under the Endangered Species Act, but are included for your consideration as it is possible that one or more of these candidates could be proposed and listed before the subject project is completed. Should the biological assessment reveal that candidate species may be adversely affected, you may wish to contact our office for technical assistance. One of the potential benefits from such technical assistance is that by exploring

alternatives early in the planning process, it may be possible to avoid conflicts that could otherwise develop, should a candidate species become listed before the project is completed.

If the proposed project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by the U.S. Army Corps of Engineers (Corps), a Corps permit shall be required, pursuant to section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act. Impacts to wetland habitats require site specific mitigation and monitoring. You may request a copy of the Service's General Mitigation and Monitoring Guidelines or submit a detailed description of the proposed impacts for specific comments and recommendations.

Please contact Michael Thabault at (916) 979-2752 if you have any questions regarding the attached list or your responsibilities under the Endangered Species Act.

Sincerely,

Cary C. Gonds

for Joel A. Medlin
Field Supervisor

Enclosures

cc: FWS, Corps Branch, Sacramento, CA

ENCLOSURE A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CANDIDATE SPECIES THAT MAY OCCUR IN THE AREA OR MAY BE AFFECTED BY PROJECTS IN THE AREA OF THE PROPOSED SACRAMENTO RIVER FLOOD CONTROL SYSTEMS EVALUATION, PHASE III, SACRAMENTO COUNTY, CALIFORNIA
(1-1-95-SP-647, April 18, 1995)

Listed Species

Fish
winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)
delta smelt, *Hypomesus transpacificus* (T)

Reptiles
giant garter snake, *Thamnophis gigas* (T)

Birds
bald eagle, *Haliaeetus leucocephalus* (E)
American peregrine falcon, *Falco peregrinus anatum* (E)
Aleutian Canada goose, *Branta canadensis leucopareia* (T)

Invertebrates
vernal pool tadpole shrimp, *Lepidurus packardi* (E)
valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)
vernal pool fairy shrimp, *Branchinecta lynchi* (T)
Conservancy fairy shrimp, *Branchinecta conservatio* (E)
delta green ground beetle, *Elaphrus viridis* (T)
delta green ground beetle - critical habitat, *Elaphrus viridis* (T)

Plants
palmate-bracted bird's beak, *Cordylanthus palmatus* (E)
Solano Grass, *Tuctoria mucronata* (E)

Proposed Species

Fish
Sacramento splittail, *Pogonichthys macrolepidotus* (PT)

Amphibians
California red-legged frog, *Rana aurora draytonii* (PE)

Plants
Contra Costa goldfields, *Lasthenia conjugens* (PE)
Colusa grass, *Neostapfia colusana* (PT)
Hartweg's golden sunburst, *Pseudobahia bahiifolia* (PE)

Candidate Species

Fish
green sturgeon, *Acipenser medirostris* (2)
longfin smelt, *Spirinchus thaleichthys* (2)
Pacific lamprey, *Lampetra tridentata* (2)
River lamprey, *Lampetra ayresi* (2)

Amphibians
western spadefoot toad, *Scaphiopus hammondi* (2)

Reptiles
California tiger salamander, *Ambystoma californiense* (1)
northwestern pond turtle, *Clemmys marmorata marmorata* (2)
southwestern pond turtle, *Clemmys marmorata pallida* (2)
California horned lizard, *Phrynosoma coronatum frontale* (2)

Birds
tricolored blackbird, *Agelaius tricolor* (2)
white-faced ibis, *Plegadis chihi* (2)
little willow flycatcher, *Empidona traillii brewsteri* (2)
mountain plover, *Charadrius montanus* (2)
Western burrowing owl, *Athene cunicularia hypugea* (2)

Mammals
Pacific western big-eared bat, *Plecotus townsendii townsendii* (2)
greater western mastiff-bat, *Eumops perotis californicus* (2)
small-footed myotis bat, *Myotis ciliolabrum* (2)
long-eared myotis bat, *Myotis evotis* (2)
fringed myotis bat, *Myotis thysanodes* (2)

Invertebrates
Sagehen Creek goeracean caddisfly, *Goeracea oregona* (2)
Antioch Dunes anthicid beetle, *Anthicus antiochensis* (2)
Sacramento anthicid beetle, *Anthicus sacramento* (2)
Sacramento Valley tiger beetle, *Cicindela hirticollis abrupta* (2R)

Plants
Suisun Marsh aster, *Aster lentus* (2)
Ferris's milk-vetch, *Astragalus tener* var. *ferrisiae* (2)
alkali milk-vetch, *Astragalus tener* var. *tener* (2R)
valley spearscale, *Atriplex joaquiniana* (2)
hispid bird's-beak, *Cordylanthus mollis* ssp. *hispidus* (2)
recurved larkspur, *Delphinium recurvatum* (2)
fragrant fritillary, *Fritillaria liliacea* (2)
adobe lily, *Fritillaria pluriflora* (2)
Carquinez goldenbush, *Isocoma arguta* (2)
Ahart's rush, *Juncus leiospermus* var. *ahartii* (1)
delta tule-pea, *Lathyrus jepsonii* var. *jepsonii* (2)
legenere, *Legenere limosa* (2)
Mason's lilaeopsis, *Lilaeopsis masonii* (2)
veiny monardella, *Monardella douglasii* ssp. *venosa* (2)
little mousetail, *Myosurus minimus* ssp. *apus* (2)
showy Indian clover, *Trifolium amoenum* (1R)

(E)--Endangered (T)--Threatened (P)--Proposed (CH)--Critical Habitat
(1)--Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)--Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.
(1R)-Recommended for Category 1 status.
(2R)-Recommended for Category 2 status.
(■)--Listing petitioned.
(*)--Possibly extinct.

Appendix

General Compensation Guidelines for the Valley Elderberry Longhorn Beetle

May 31, 1994

General Compensation Guidelines for the
Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) was listed as a threatened species in 1980 (45 Federal Register 52807). This animal is fully protected under the Endangered Species Act of 1973, as amended (Act). The larvae of the beetle feed and mature within elderberry (*Sambucus* sp.) shrubs. Use of the plants by the early stages of this insect, a wood borer, is very rarely apparent. Frequently, the only exterior evidence of use of the shrub is the exit hole created by the larvae prior to the pupal stage. The beetle has been found in elderberry plants with stems possessing a diameter of one inch or greater. The range of the animal extends from Redding south to Bakersfield and from the western foothills of the Sierra Nevada to the eastern foothills of the coast range (Barr 1991; U.S. Fish and Wildlife Service 1984).

An adequate survey should be completed by a qualified biologist for the valley elderberry longhorn beetle and its elderberry foodplant if the proposed project site is located within the range of the animal. The report should include the precise location of all elderberry shrubs, their height and diameter, the presence of adult exit holes and the general condition of the plants. A map should also be included with the report indicating the major vegetational communities present on site. The completed study should be sent to the U.S. Fish and Wildlife Service (Service) for review.

Take incidental to an otherwise lawful activity may be authorized by one of two procedures. If a Federal agency is involved with the permitting, funding, or carrying out of the project, then initiation of formal consultation between that agency and the Service pursuant to section 7 of the Act is required if it is determined that the proposed project may affect a federally listed species. Such consultation would result in a biological opinion that addresses the anticipated effects of the project to the listed species and may authorize a limited level of incidental take. If a Federal agency is not involved with the project, and federally listed species may be taken as part of the project, then an incidental take permit pursuant to section 10(a) of the Act would need to be obtained. The Service may issue such a permit upon completion of a satisfactory conservation plan for the listed species that would be affected by the project.

The following mitigations should be undertaken for the valley elderberry longhorn beetle:

Avoid Habitat Whenever Possible

1. Fence and flag each elderberry shrub or group of these plants so that the construction crew can avoid them. There should be a setback of at least twenty feet from the dripline of each elderberry shrub. The area must be designated to prevent isolation of the beetle population from other

ENCLOSURE B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a) Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species; 2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and 3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7(c) Biological Assessment--Major Construction Activity[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action[2] on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may proceed; however, no construction may begin.

We recommend the following for inclusion in the BA: an on-site inspection of the area affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat are present; a review of literature and scientific data to determine species' distribution, habitat needs, and other biological requirements; interviews with experts, including those within FWS, State conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of indirect effects of the proposal on the species and its habitat; an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to our office.

---

[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

[2] "Effects of the action" refers to the direct and indirect effects on an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

populations located in adjacent areas. The area should be designated as habitat for the valley elderberry longhorn beetle in perpetuity.

Brief contractors on the requirements to avoid damaging the elderberry plants and the possible penalties for not complying with these provisions. These areas should be adequately signed with the following information: "This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines and imprisonment." The signs should be clearly readable from a distance of at least twenty feet.

Work crews should be informed about the status of the threatened valley elderberry longhorn beetle and the need to protect its elderberry host plant. All on-site personnel should receive instruction regarding the presence of the federally protected animal.

Transplant Elderberry Shrubs

Elderberry shrubs should be transplanted if they can not be avoided by the proposed project. All elderberry plants with a stem diameter of 1.0 inch or greater in size at ground level should be transplanted to a mitigation area. In some cases, a shrub that would be extremely difficult to remove because of access problems or one that is in such poor condition that it is unlikely to survive being transplanted may be exempted from this requirement at the Service's discretion.

A qualified biologist (monitor) should be on-site for the duration of the transplanting of the elderberry shrubs to insure that no unnecessary take of the valley elderberry longhorn beetle occurs. The biologist utilized should have the authority to stop all activities until appropriate corrective measures have been completed. The biologist should also be required to report violations immediately to the Service and the California Department of Fish and Game.

1. <u>Timing</u>.--Elderberry shrubs with stems equal to or greater than 1.0 inches in diameter in ground level should be transplanted when the plant is dormant (approximately November through the first two weeks in February) after they have lost their leaves and, thus, the plants essentially are not transpiring or actively growing. Planting during the non-growing season will reduce the shock to the plant and increase transplantation success.

2. <u>Procedure to plant elderberry shrubs</u>.

a. Cut tree back to 3 to 6 feet from the ground or to 50 percent of its height (whichever is greater) by removing branches and stems above this height. The trunk and all stems greater than 1.0 inches in diameter measured at ground level should be replanted.

b. Excavate a hole 3 to 4 feet deep to receive the planting;

c. Dig plant up using Vemeer spade, backhoe, front end loader, or other suitable equipment, taking as much of the root ball as possible, and replant immediately at the compensation site. Move plant only by the root ball. If the plant is to be moved and transplanted off site, wrap the root ball in burlap and secure with wire. Dampen burlap with water, as necessary, to keep root ball wet;

d. The elderberry shrub should be planted in a water retention basin 40 feet by 40 feet in size (1600 square feet). The root ball should be planted so it is level with the existing ground. Compact the soil sufficiently so that settlement does not occur. A basin 40 feet by 40 feet should be provided for every five seedling elderberry plants and associated native vegetation (see number 4 below);

e. Saturate soil with water. Do not use fertilizers or other supplements or paint the tips of stems with pruning substance as the effects of these compounds on the beetle are unknown;

f. Monitor to ascertain if additional watering is necessary:

1. if sandy, well-drained soil, plants may need to be watered weekly or possibly twice monthly;

2. if clay, poorly-drained soil, it may not be necessary to water after the initial saturation.

A drip watering system and timer would be ideal. However, in situations where this is not possible, a water truck or other apparatus may be used.

Sixteen hundred (1600) square feet should be provided for each avoided elderberry shrub; each transplanted elderberry shrubs; and every five seedling elderberry plants and associated native plants. The mitigation area should be designated as habitat for the valley elderberry longhorn beetle in perpetuity. The mitigation area should be designated to prevent isolation of the beetle population from other populations located in adjacent areas. A conservation easement or fee title for the mitigation area should be given to a resource agency or appropriate private organization. The fee title or conservation easement should include adequate funding that ensures management of the mitigation area in perpetuity. The Service should be provided with a map and written details specifically identifying the mitigation area prior to the initiation of the mitigation program.

3. Procedure to plant additional stems.--Each stem 1.0 inches or greater in diameter at ground level that is moved or destroyed will be replaced with seedling elderberry plants in the mitigation area using a ratio from 2:1 to 5:1. This replacement requirement applies even if the elderberry shrub is transplanted. Replacement stock should be obtained from local sources. The approval of the Service should be obtained prior to initiating the compensation program. The ratio is determined as follows:

Ratio of 2:1 Elderberry shrubs with stem diameters 1.0 inch or greater at ground level and there are no adult emergence holes.

Ratio of 3:1 Elderberry shrubs with stem diameters 1.0 inch or greater at ground level. Beetles are present as evidenced by emergence holes, but occur in 50 percent or less of the shrubs.

Ratio of 5:1 Elderberry shrubs with stem diameters 1.0 inch or greater in size at ground level. Beetles are present as evidenced by emergence holes, and occur in 51 percent or greater of the shrubs.

4. Plant associated native plants: Recent studies have found that beetles are more abundant in more dense native plant communities with a mature overstory and mixed understory versus a young overstory and low understory. Therefore, a mix of native plants associated with the elderberry shrubs at the

project site should be planted at a ratio of at least two specimens of all native tree and shrub species for every five elderberry stems equal to or greater than 1 inch in diameter at ground level. These plantings also must be monitored with the same survival criteria utilized for the elderberry plants. The saplings and seedlings, as appropriate, should be from native populations at the project site or from the immediate project vicinity. The approval by the Service of the native plant donor sites must be obtained prior to initiation of any of the revegetation work.

Example 1

Total number of elderberry shrubs on project site: 20
Associated native plants: interior live oak (*Quercus wislizenii*), foothill pine (*Pinus sabiniana*), and California buckeye (*Aesculus californica*)
Number of elderberry shrubs with evidence of the the valley elderberry longhorn beetle: 12
Number of stems equal or greater than 1 inch: 100
Compensation: Transplant the 20 elderberry shrubs that will be impacted, plant 500 elderberry seedlings (ratio of 5:1), plant 40 interior live oaks, 40 foothill pines, 40 California buckeyes
Total area required: 4.41 acres

Example 2

Total number of elderberry shrubs: 10
Associated native plants: interior live oak (*Quercus wislizenii*)
Number of elderberry shrubs with evidence of the valley elderberry longhorn beetle: 0
Number of stems greater or equal to 1.0 inch: 0
Compensation required - None

Example 3

Total number of elderberry shrubs: 5
Associated native plants: cottonwood (*Populus fremontii*)
Number of elderberry shrubs with evidence of the valley elderberry longhorn beetle: 0
Number of stems equal or greater than 1.0 inch: 15
Compensation required: Transplant the 5 elderberry shrubs, plant 30 elderberry seedlings (ratio 2:1), plant 6 cottonwoods
Total area required: .40 acre

Example 4

Total number of elderberry shrubs: 25
Associated native plants: none
Number of elderberry shrubs with evidence of the the valley elderberry longhorn beetle: 7
Number of stems equal or greater than 1.0 inch: 150
Compensation required: Transplant the 25 elderberry shrubs, plant 450 stems (ratio 3:1)
Total area required: 4.22 acres

Provide Habitat for the Beetle in Perpetuity

Weeds and other plants that are not native to the mitigation area should be removed at least once a year or at the discretion of the Service or the California Department of Fish and Game. Mechanical means should be used; herbicides should be prohibited.

Measures should be taken to insure that no pesticides, herbicides, or other chemical agents enters the mitigation area. No spraying of these agents should be conducted within one hundred (100) feet of the area or if they have the potential to drift, flow or be washed into the area in the opinion of biologists or law enforcement personnel from the California Department of Fish and Game or the Service. The Service should be provided with written documentation that this condition will be carried out in perpetuity.

No dumping of trash or other material should occur within the mitigation area. Any trash or other material should be removed within ten (10) working days of discovery. The Service should be provided with written documentation that this condition will be carried out in perpetuity.

Biologists and law enforcement personnel from the California Department of Fish and Game and the Service should be given complete access to the project site to monitor transplanting activities. Personnel from both these agencies should be given complete access to the project and the mitigation area to monitor the valley elderberry longhorn beetle and its elderberry shrub habitat in perpetuity.

If appropriate, permanent fencing should be placed completely around the mitigation area to prevent unauthorized entry by off-road vehicles, equestrians, or other parties that may damage or destroy the habitat of the beetle. The applicant should receive approval from the Service that the fencing is acceptable prior to initiation of the mitigation program.

If appropriate, a minimum of two prominent signs should be placed and maintained in perpetuity at the mitigation area noting that the site is habitat of the federally threatened valley elderberry longhorn beetle and including information on the beetle's biology and ecology. The signs should be approved by the Service. They should be replaced or repaired within ten (10) working days if they are found to be damaged or destroyed.

Monitoring Program

The population of the adults of the threatened valley elderberry longhorn beetle, the general condition of the mitigation area, and the elderberry plants and associated native plants located at the mitigation area should be monitored by a qualified biologist annually for a period of ten years beginning with the date the mitigation program is initiated. Two visits between February 14 and June 30 of each year should be made beginning the year the mitigation is begun. The study should include a population census of the adult beetles, including the actual number of animals observed, their condition, behavior, and precise location at the site; a census of the elderberry shrubs and associated native plants, including the number of plants observed, their size, and condition; and a general assessment of the habitat, including any real or potential threats to the beetle, and its food plants,

such as erosion, excessive grazing by livestock, off-road vehicle use, etc. Random-walk counts should be used; mark-recapture or other methods that involve handling or harassment shall not be utilized. The materials and methods that will be utilized for this study should be reviewed and approved by the Service. All appropriate Federal and State permits should be obtained prior to initiating the field studies.

A written report analyzing the data from the monitoring of the threatened valley elderberry longhorn beetle at the mitigation area and the elderberry shrubs and associated native plants located at the project site should be conveyed to the Service and the Department of Fish and Game (Supervisor, Environmental Service, Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814, and Staff Zoologist, California Natural Diversity Data Base, Department of Fish and Game, 1220 S Street, Sacramento, California 95814) by December 31 of each year for a ten year period beginning with the date the program is initiated. The report should include, but not be limited to, the raw data collected during the field surveys and a basic analysis of the population dynamics of the valley elderberry longhorn beetle at the compensation sites. The population size (qualitative) should be estimated for the beetle. Maps showing where the individual adult beetles and exit holes were observed should be included. For the elderberry shrubs and associated native plants the following should be analyzed: the survival rate, condition, and size of the plants. Real and likely future threats should be addressed along with suggested mitigations (e.g. fencing access to off-road vehicles, more frequent removal of exotic vegetation, etc.). The original field notes, photographs, correspondence, and all other pertinent material, as well as a copy of the report should be deposited and accessioned into the Entomology Department, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118 by December 31 of each year for a ten year period beginning with the date the mitigation program is initiated. The Sacramento Field Office should be provided with the accession numbers given to this material by the California Academy of Sciences.

Success Criteria

A survival rate of 80% of the elderberry shrubs and associated native plants should be obtained at the end of the ten year monitoring program. The Service will make the determination as to the compensator's replacement responsibilities arising from circumstances beyond its control such as plants damaged or killed as the result of severe flooding or vandalism.

Future Revisions

Revegetating with elderberries and the responses of the beetle to such revegetation efforts is a relatively new procedure. As data become available on which to evaluate this technique, revisions to these guidelines are anticipated.

Service Contact

These guidelines were prepared by Chris Nagano, Sacramento Field Office, U.S. Fish and Wildlife Service, 2800 Cottage Way, Room E-1823, Sacramento, California 95825. Please refer any questions on these guidelines to him at the above address or call 916/978-4866 extension 358.

Literature Cited

Barr, C.B. 1991. The distribution, habitat, and status of the valley elderberry longhorn beetle *Desmocerus californicus dimorphus*. Sacramento Field Office, U.S. Fish and Wildlife Service, Sacramento, California

U.S. Fish and Wildlife Service. 1984. Recovery plan for the valley elderberry longhorn beetle. Endangered Species Program. Portland, OR.

Appendix C

Responses to Comments

APPENDIX E

SACRAMENTO RIVER FLOOD CONTROL PROJECT
PHASE III, MID-VALLEY AREA

MITIGATION PLANTING DESIGN

APPENDIX E

July 1995

SACRAMENTO DISTRICT
**US ARMY CORPS
OF ENGINEERS**

APPENDIX E
MITIGATION PLANTING DESIGN

SACRAMENTO RIVER FLOOD CONTROL PROJECT
Phase III, Mid-Valley Area

TABLE OF CONTENTS

TABLES

MAPS

APPENDIX E
MITIGATION PLANTING DESIGN

SACRAMENTO RIVER FLOOD CONTROL PROJECT
Phase III, Mid-Valley Area

1. INTRODUCTION

The mitigation planting design, for the Sacramento River Flood Control Project, Mid-Valley Area has been developed to mitigate for losses due to construction of the flood control facilities. This report is a part of the Design Memorandum for the above mentioned project. This section does not address the permanent wetland and emergent marsh requirements. These will be re-established on-site and will not require establishment apart from that effort, see mitigation section of the draft EA-IS.

2. BASIS OF DESIGN

Full compensation to achieve all project mitigation requirements add up to 65.04 acres for terrestrial vegetation. Additionally, 365 trees are included as compensation for the removal of 73 trees that were not associated with any of these targeted habitats. Compensation for these trees have been included within the planting densities in the plan with no additional acreage associated with it. See Table T-1 for cover type acreage.

2.1 Riparian Woodland

Full compensation for riparian woodland habitat requires development of 11.74 acres. Riparian woodland tree canopy consists primarily of upper story species, such as: valley oak, sycamore, cottonwood, and willow among other secondary species. See species mix listed in Table T-2.

2.2 Scrub-scrub

Full compensation for shrub-scrub requires development of 4.59 acres. Shrub-scrub is defined as habitat dominated by woody vegetation less than 20 feet tall. Species includes shrubs, young trees, and trees and shrubs that are small or stunted because of environmental conditions. Species mix include all species listed in Table T-2 at some point in time.

2.3 VELB Compensation

The project will adversely impact 12 clumps of Blue

Elderberries, which requires 53.3 acres as compensation, as well as, transplanting of the 12 clumps. As part of the 53.3 acres, a 4.59 acres credit is being given to this acreage from the shrub-scrub requirement, thereby leaving the Elderberry (VELB) compensation requirement at 48.71 acres. The requirement also includes planting associated species with the elderberry transplants and seedlings to achieve the full compensation for lost habitat.

2.4 Grassland/Agriculture

Also addressed in this design is the establishment of a cover crop for 199.69 acres. This will consist of native grass species as indicated in Table T-4. Effort here will be to protect all disturbed soil with grasses as a erosion control measure.

Table T-1
List of
Compensation Cover-type
with Associated Acreage

Habitat Type	Cover Crop Seeding	Terrestrial Planting
Riparian Woodland		11.74
Shrub-scrub		4.59
VELB Compensation		48.71*
Grassland / Agriculture	199.69	
TOTAL	199.69	65.04

* The 4.59 acres of shrub-scrub is applied to the VELB Compensation acreage to achieve the total 53.3 acre requirement. This leaves a requirement of only 48.71 acres for the VELB Compensation to make up the difference.

3. ESTABLISHMENT PERIOD AND DESIGN GOALS

3.1 Establishment Period

The mitigation design is based on a 3 year establishment period. This length of time has been determined in coordination with the project design goals.

3.2 Design Goals

The targeted canopy cover goals, as indicated in the draft EA-

IS Mitigation Design, is to achieve 60-80% canopy cover by end of the 52-year period of analysis for the riparian woodland and 60-80% canopy cover within 10 years for the shrub-scrub. To achieve this goal the riparian species will be planted at a density of 450 plants per acre. This design will ultimately achieve a minimum survival of 300 plants per acre. This target population goal has lead to the initial design of the project and the determination of the initial planting density and requirements necessary to achieve this final goal. This number is allowing for mortality at the following stages: initial die-off at installation, mortality throughout establishment period, initial die-off after irrigation system is removed, and the final die-off of all plants that do not have sufficient root development to sustain growth thereafter. Survival and mortality numbers are based upon past Sacramento River Flood Control Mitigation Projects.

4. MITIGATION LOCATION SITES

Three potential sites have been identified by FWS in the CAR. These sites will serve as typical of the type of sites that would be representative for this type of revegetation. The sites are located in the vicinity of the Sacramento River between river mile 80 and 85. Map L-1 shows the locations of the three sites.

Site #1 is located at Sacramento River mile 80.0 right (SR 80.0R) adjacent to the river and near the confluence of the Feather River, see Map L-2. Site #1 is 60.0 acres and is composed of fallow fields containing weeds and is surrounded by riparian forest. Site #2 is located at SR 84.0L adjacent to the river, see Map L-3. Site #2 is 70.0 acres and is located within the Sutter Bypass just north of Gray's Bend. This site is currently farmed for safflower. Site #3 is located within the Sutter Bypass south of the Sacramento Slough along the East Canal, see Map L-4. This site is located near the Sacramento River and currently supports a jojoba crop.

5. CONSTRUCTION SCHEDULING

All requirements of this project shall be coordinated in determining the project schedule. Consideration shall be given to the proper time of year one item must be done with the requirements of competing items. Project requirements shall be planned in a systematic manner so that each item is started and completed at the optimum time. Soil and water testing, water source development, site preparation, cover crop seeding, elderberry transplanting, seed collection and propagation, irrigation installation, plant installation, maintenance, as-builts, and reports shall be addressed in the coordination

schedule. The schedule shall utilize the start of the rainy season to install the cover crop and container plant material. This is typically considered to be around the 15th of November in this region. Elderberry transplanting and pole cutting installation shall occur during dormancy and shall be coordinated with the levee construction work. This may vary from season to season but is typically December through February. All plant installation shall be completed prior to "bud-break" in Spring.

6. SITE EXPLORATION

Surface soil and groundwater shall be tested prior to award of the installation contract for the mitigation items. A purchase order shall be prepared in advance to determine the status of the soil and water conditions. The designer will use this information to determine its affects on the plants and its potential for success.

6.1 Soil Testing

Soil Testing shall determine if additional amendments are necessary to correct any deficiency that may exist. The soil test shall identify soil characteristics such as texture, structure, alkalinity, nutrient status, organic content, soil reaction, and salinity. The test shall also determine if and to what depth hardpan exists beneath each site. The test shall recommend the necessary corrections to the soil problems. The soils report shall consider and recommend if "chimney holes" should be drilled below each plant. All deficiencies that will retard the plants growth shall be addressed in, and corrected as part of, the mitigation plan.

6.2 Groundwater Testing

Groundwater testing shall determine how far the groundwater is below the surface. Groundwater testing shall be conducted at all site locations. Groundwater sampling and analysis shall determine deficiencies or detriments that might exist for proper plant growth. All tests shall recommend the necessary corrections to the water quality problem.

7. PLANT MATERIAL

7.1 Plant Species

Plants designated for installation are native to the local riparian zone and are species that are presently found in the project area and/or species that have historically been known

to exist in the project area. All plants shall be in accordance with the species identified in Table T-2. All subsequent reference to the plants listed will be referred to using their common names. This will aid the reader who is not familiar with the pronunciation of the plants scientific name.

Table T-2 Mid-Valley Area Plant Species and Density Plan for All sites		
Scientific Name / Common Name	**TOTAL FOR ALL SITES**	**Beaver Cage[1]**
TREES		
Acer negundo ssp. californicum / Box Elder	3222	3222
Alnus rhombifolia / California White Alder	1658	0
Fraxinus latifolia / Oregon Ash	1658	1658
Juglans hindsii / California Black Walnut	2190	0
Platanus racemosa / California Sycamore	1658	0
Populus fremontii / Fremont Cottonwood	2690	2690
Quercus lobata / California Valley Oak	3222	0
Salix laevigata / Red Willow	1658	1658
SITE TOTALS FOR TREES	17,956.00	9,228.00
SHRUBS		
Baccharis viminea / Mule Fat	1144	0
Rosa californica / California Wild Rose	1675	0
Rubus vitifolius / California Blackberry	1675	0
Salix hindsiana / Sandbar Willow	1675	0
Salix gooddingii / Black Willow	1144	1143
Sambucus mexicana / Blue Elderberry	3999	0
SITE TOTALS FOR SHRUBS	11,312.00	1143
TOTAL FOR BOTH TREES AND SHRUBS	29268	10371

[1] = Beaver Cage amounts shown are included within the individual species totals and are not in addition to.
for each species. Some species will be installed using a couple of different techniques, i.e.; direct seed and as a nursery grown tree pot.

7.2 Planting Densities

Planting densities for all terrestrial woody vegetation shall be 450 plants per acre (PPA). This density places the plants at approximately 10' centers. The elderberry requirement is the dominant species targeted. This has dictated the higher percentages used. Most elderberry habitats occur in association with other native terrestrial plants, therefore, associated species have been included into the planting design. Pure species stands of elderberries do occur but are less common in the riparian system, therefore the planting palette will provide a species base that is representative of a diverse system and not a monoculture. See Table T-2 Species and Density Plan for All Sites.

Past Sacramento River Bank Protection Projects (SRBPP) similar in design to this project have provided results with which we can estimate survival and mortality results. The first project, Unit 41A had approximately 67% survival rate at the end of the 3 year maintenance period. Subsequent similar Sac Bank projects have had notably higher survival rates; 40BM, 84%; and 42M1, 86%. Die-off subsequent to termination of irrigation has resulted in from 1-10%. It is anticipated that similar die-off will occur with this design.

The target survival goal is based on the following formula: Initial planting will be at 450 PPA, the expected mortality at the end of the 3 year maintenance period is projected to be 135 PPA or (30%), which leaves a 315 PPA plant survival, additional mortality will occur after the maintenance ends and is anticipated to be roughly 10% (worst case of the original number) leaving an estimated 270 plants per acre survival. This leaves the remaining plants at roughly 13 feet centers. The target goal of 60-80% canopy cover will be easily achieved by the estimated survival.

7.3 Elderberry Transplanting

Existing elderberry plants that have been targeted to be removed shall be transplanted onto the project sites. In addition to the removal and transplanting of these elderberries, additional elderberry seedlings are required as compensation for the impacts due to project construction. All elderberry transplanting shall be in accordance with the General Compensation Guidelines for Valley Elderberry Longhorn Beetle, dated July 14, 1988, as prepared by the Endangered Species Office, U.S. Fish and Wildlife Service, Sacramento, California.

7.4 Plant Material Acquisition

All plant material shall be collected from seed from the general vicinity of the sites. Collection shall be made from a number of representative material sources to ensure diversity and viability of the material. Table T-3 outlines the propagule type, nursery stock size, and collection time

Consider the seed collection and propagation time necessary to have the plant stock at the proper size at planting time. Depending on the particular species involved, the seed becomes viable at differing times of the year. Generally, late summer, fall, and early winter are when most seeds can be collected. The seed shall be stored in refrigeration until it is needed. The time for germinating the seed and placing in containers shall be coordinated with the actual field plant installation time. The plant material shall be at its optimum size when installed.

7.4.1 Seed Collection

Seed shall be collected at the time as indicated in Table T-3, and stored in refrigeration until usage. Scarification, stratification, and/or other germination techniques shall be employed as appropriate for each species. Sufficient quantities of seed shall be collected to ensure an adequate supply of planting material is achieved.

7.4.2 Cutting Collection

Where pole cuttings are required, the contractor shall selectively cut shoots of the proper size without damage to the tree or the area in general. The removal of shoots shall not excessively deplete the area to the degree that it cannot both physically or visually recover to its original condition.

7.4.3 Alternate Plant Material Source

The plant material list may contain species that are not found adjacent to the site. In these cases, it is acceptable to collect from sources in the vicinity of the river that is within a 15 mile radius of the site. The contractor may supplement the material through commercial means, where existing plant material is unavailable in sufficient quantities.

Table T-3
Mid-Valley Area
Preliminary List of Propagule and Nursery Stock

Scientific Name	Type of Propagule and Nursery Stock	Collection Time
TREES		
Acer negundo	Tree pot from seed	fall
Aesculus calif.	direct seed/tree pot from seed	fall - late fall
Alnus rhombifolia	Tree pot from seed	late summer - fall
Fraxinus latifolia	Tree pot from seed	fall
Juglans hindsii	direct seed/tree pot from seed	fall
Platanus racemosa	Tree pot from seed/pole cutting	late summer - fall
Populus fremontii	Pole cutting	mid winter
Quercus lobata	direct seed	fall - late fall
Salix laevigata	Pole cutting	mid winter
SHRUBS		
Baccharis pilularis	Deepot from seed	fall
Baccharis viminea	Deepot from seed	fall
Cephalanthus occ.	Pole cutting	mid winter
Rosa californica	Deepot from cutting or seed	winter
Rubus vitifolius	Deepot from cutting or seed	winter
Salix hindsiana	Pole cutting	mid winter
Salix gooddingii	Pole cutting	mid winter
Sambucus mexicana	Tree pot from seed	fall
HERBACEOUS		
Scirpus acutus	Direct plant from plugs	winter

8. SITE PREPARATION

All planting sites require site preparation prior to all plant installation items. The site preparation shall be designed to prevent weed competition of the exotic species existing on site. Prior to plant installation, the soil shall be prepared for a cover crop by discing the entire site. After the site has been disced, soil amendments (as determined by the soils test) shall be thoroughly incorporated into the soil to a 6" depth.

8.1 Cover Crop Seeding

The cover crop seed shall be spread over the site and raked so that the seed is covered with 1/4" of soil. Seeding shall be performed just prior to the start of the rainy season, typically, 15 November. All seeds shall be tested for viability prior to seeding. See Table T-4 for cover crop species and seeding rates.

Table T-4
Mid-Valley Area
Preliminary Cover Crop Species

Scientific Name	Common Name	Rate
Herdeum brachyantherum	Meadow Barley	20 lbs/acre
Bromus carinatus	California Brome	10 lbs/acre
Elymus glaucus	Blue Wildrye	10 lbs/acre
Stipa pulchra	Purple Needle Grass	10 lbs/acre
Eschscholzia californica	California Poppy	5 lbs/acre
TOTAL		55 lbs/acre

9. IRRIGATION DESIGN

9.1 Water Source

The contractor shall provide a water source for each mitigation site. The source shall be adequate to provide for the irrigation method used and shall be able to deliver the required amounts at the frequency specified. The project has riparian use rights to draw water directly from the Sacramento River for use if so desired.

9.2 Irrigation Method

The irrigation method used to water the plants shall be a bubbler, drip or some type of modified drip system. Considering the size of the project, it is the most efficient method available, both with water delivery and system costs. On past Corps mitigation projects other delivery systems have been used with less success. Truck watering has proven effective on small sites only. Truck watering is harder to control. Damage to the soil and root exposure at the base of the plant from erosion is prevalent problem with this type of

system. And the time it takes to deliver the required amount of water for the entire project makes truck watering a very labor intensive method. Also, controlling and monitoring the application rate is difficult and inconsistent over time. Overhead spray tends to encourage weed growth and uses water inefficiently and is not desirable on this project.

10. PLANTING DESIGN

The planting designs target goal is the establishment of native vegetation for the above mentioned habitats. The revegetation contract will be separated from the levee construction work and carried out by a contractor familiar with plant restoration projects. The contractor shall be familiar with native plant material and planting techniques as required for this project. They shall exhibit qualification and experience in successfully performing similar type of work. Their experience shall exhibit long-term maintenance performed on similar past project. Their responsibilities shall have included evaluation, documentation, and monitoring of these projects. The requirements listed below detail all elements necessary to achieve these goals.

The planting design shall consider the particular conditions of the site and place the appropriate species accordingly. Plant placement considerations shall include: the orientation of the site, the aspect, groundwater depth, the distance from the river, and the exposure to the wind and sun that may cause additional evapotranspiration.

10.1 Planting Techniques

The planting technique(s) used for each species shall be for the type of plant propagule and/or nursery stock indicated in Table T-3. The planting pit shall be dug for what is appropriate for the type of plant material used. All plants shall be installed within a browse guard and bottomless subgrade rodent guard. Fertilizer shall be supplied with each plant, using a slow release 14:14:14 Osmocote. The fertilizer shall be placed in the bottom of the planting pit and not in contact with the plant roots. The plant shall be thoroughly watered-in at planting. Guards, and where appropriate beaver barrier cages, shall be installed to protect the plant. The majority of the mitigation areas are relatively level. A mulch weed control material shall be installed at the surface and shall completely cover the water retention basin. The mulch shall restrict sunlight and be water permeable. All planting techniques shall employ the mulch material. See Maps, sheet L-5 for planting details.

10.1.1 Seedling Planting

Seedlings shall be set upright within the browse/rodent guard. Ensure the root mass is evenly spread over the planting zone. The planting pit shall be twice the width and depth of the rootball. The root crown for seedlings shall be 1/2" above the surrounding grade. Fertilizer and mulch shall be placed as indicated. A water retention basin shall continuously surround the plant. See Map L-5 for details.

10.1.2 Direct Seed Planting

Direct seed shall be placed in the browse/rodent guard to the depth of twice the diameter of the seed. Fertilizer and mulch shall be placed as indicated. See Map L-5 for details.

10.1.3 Pole Cutting Planting

Pole cuttings shall be placed within the browse/rodent guard with the fertilizer and mulch as indicated. Pole cutting material shall be a minimum 4' long and no greater than 1-1/2" in diameter. The material shall be installed with 12" above grade (at least 2 nodes exposed) and 3' below grade. See Map L-5 for details.

10.1.4 Transplanting

Transplant material shall be planted the same day it is collected. Plants must be kept moist and cool during storage and transportation and protected from direct exposure to wind and sunlight while out of the ground. Standard removal of the material to be transplanted shall be with a 84" tree spade. Variations may be acceptable based on access difficulty.

10.2 Plant Protection

Each plant shall be provided with a plant protection browse/rodent guard placed around the plant. The guard shall extend to a height of 18" above the adjacent grade. The guard shall be continuous and capable of being opened or removed as the plant matures.

Past mitigation projects along the Sacramento River and its tributaries have had damage on an on-going basis from beavers. All previous mitigation sites have sustained beaver damage on

one year old (and older) plants. It has become necessary to retrofit these projects with beaver barrier cages to stop the damage. It is anticipated that beaver damage to the plants will be a problem on this project as well. Therefore, a continuous welded wire fence shall be constructed along the outer perimeter of the site where it adjoins the river's edge.

10.3 Signage

All sites shall be provided with signs identifying the activity and authority of the work being undertaken. The contractor shall provide 15 signs. The sign shall be as indicated on Map L-5 details.

11. ESTABLISHMENT DESIGN

The contractor shall be responsible to perform all necessary establishment items. The establishment plan is to ensure the best possible opportunity for plant survivability. All items listed below have been developed, used, and refined on previous similar mitigation projects and will ensure the targeted degree of survivability.

11.1 Weeding

A coordinated weed control program shall be incorporated into the mitigation planting design. As stated in paragraph "Planting Techniques", each individual plant shall receive a mulch weed control material that will suppress weed growth. The cover crop that was initially installed will continue to provide a benefit to each plant by suppressing the unwanted weed seeds in the area. Composition and rate of application of fertilizer shall be as recommended by the nursery for the species used. See Table T-4 for cover crop species.

11.2 Watering

Each plant shall receive watering immediately at installation. The irrigation system shall be completed and operable prior to plant installation. Individual plant water requirements dictate the need for a dependable irrigation system through the duration of the establishment period. Past experience of SRBPP has shown that minimal water for these riparian species will cause a high degree of mortality. Therefore this design is based on an abundant water.

11.2.1 Watering Concept

The amount of water needed by each plant will vary over time. We have learned from former Corps mitigation projects that the "little water concept" of irrigation does not work for these type of mitigation projects unless you accept a very high degree of mortality. The design of this project is based on a "controlled mortality rate" in order to achieve its targeted goal. The weather cycle in California will continue to average out to have long hot summers with little to no rainfall. Drought tends to be more common then not in that it tends to last longer than our rainier seasons.

11.2.2 Irrigation Frequency and Rate

Irrigation shall be required from April through November throughout the duration of the establishment period. At any time during the winter months when 1/2" of moisture has not fallen within a 6 week period, the contractor shall provide a complete cycle of irrigation for each plant equivalent at the previous years irrigation rate. During construction, the plants shall be watered at 5 gallons per plant. During the Establishment Period (after Installation Acceptance), each plant shall receive a minimum of 10, 20, & 30 gallons of water per week, for the first three years, respectively. At all times the contractor shall ensure that the water retention basin is adequate to contain and direct the water to the plant's root zone. If runoff occurs, the water retention basin shall be adjusted and/or enlarged to correct the situation. At all times, all required irrigation water shall be available to the plants roots.

11.3 Damage Restoration and Repair

Maintenance of all installation items shall be the responsibility of the contractor through the duration of the installation and establishment periods. These items shall include: signs, planting guards, beaver barrier fencing, and mulch material. It is the contractor's responsibility to maintain these items, and if required, restore them to their original condition. If a damaged item is un-repairable, it shall be replaced with new material. The contractor shall be responsible for all damage from vandalism, rodents, insects, fire, flood (irrigation system only), and chemical spray. The contractor shall police these sites for the duration of the contract.

11.4 Plant Replacement Requirements

The mitigation design allows 15% mortality at the end of the first year maintenance. The second year 30% (of the original amount installed) mortality is acceptable. Any mortality above these percentages requires the contractor to replant a new Deepot size plant to achieve the acceptable percentages. There is no replacement requirement for the end of the third year survival. Since the end of the third year is the end of the contract, it would prove futile to install plants with no future means of watering them. It will be the Corps responsibility to ensure that all establishment requirements are being met by the contractor during this period. Past projects have shown this to work, with no significant problems with enforcement.

12. RECORDS AND REPORTS

The proper documentation of the events and conditions of this project will be required of the contractor. These records serve as historical records in evaluating successes and failures as they might apply to the project. Continuously updated as-builts shall be kept by the contractor and yearly reports shall be kept and submitted documenting survival results and projects conditions. A final report at the end of the project will serve as a record and provide valuable information for future projects.

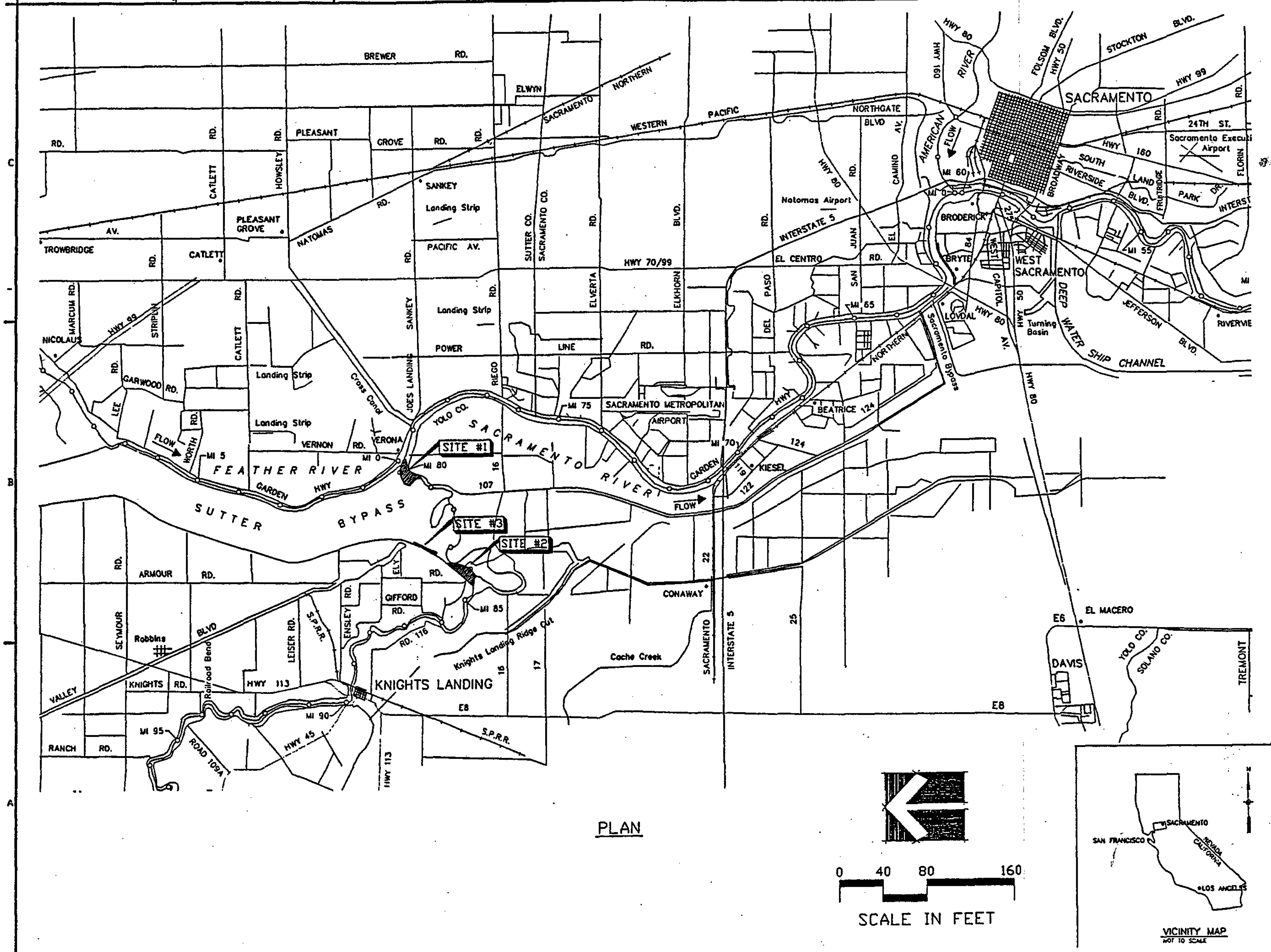
13. CLEANUP

The contractor shall be responsible for maintaining and leaving the project in a natural looking condition. All installation and establishment items shall be disposed of properly. All browse/rodent guard and mulch fabric (if used) shall be removed from the plants and discarded. Beaver barrier fencing will be left intact in a good, secure, and upright condition.

14. MITIGATION MONITORING PROGRAM

This project is based on the requirement to mitigation for habitat lost due to levee work on reaches of the Sacramento River and its tributaries. It is necessary to document the progress of the project to ensure the effort is meeting the initial requirement. A monitoring plan shall be set up documenting conditions at periodic intervals throughout the life of the project as required by the Environmental Assessment (EA-IS). The monitoring program shall address all forms of wildlife targeted in the EA-IS, as well as, the success of the vegetative habitat targeted here.

The monitoring program shall document the progress of the project and the success of the revegetation effort. Progress projections shall determine if the targeted habitats are developing successfully and on time. Plant density, cover, and general species composition shall be considered in determining success of effort. Careful consideration has been taken to reintroduce those species that "might" have occurred there naturally. In the case that one species does not do well at a particular site, it should not be considered a negative result. Replacement of that species should not necessarily follow. It is quite probable that the site, as exists today, is not conducive to some species. The initial plant palette is representative of the native vegetation in the area and should not become sacred itself. The success of the project should be judged on achieving self-sufficiency of the native plants installed and its successive regeneration over time.



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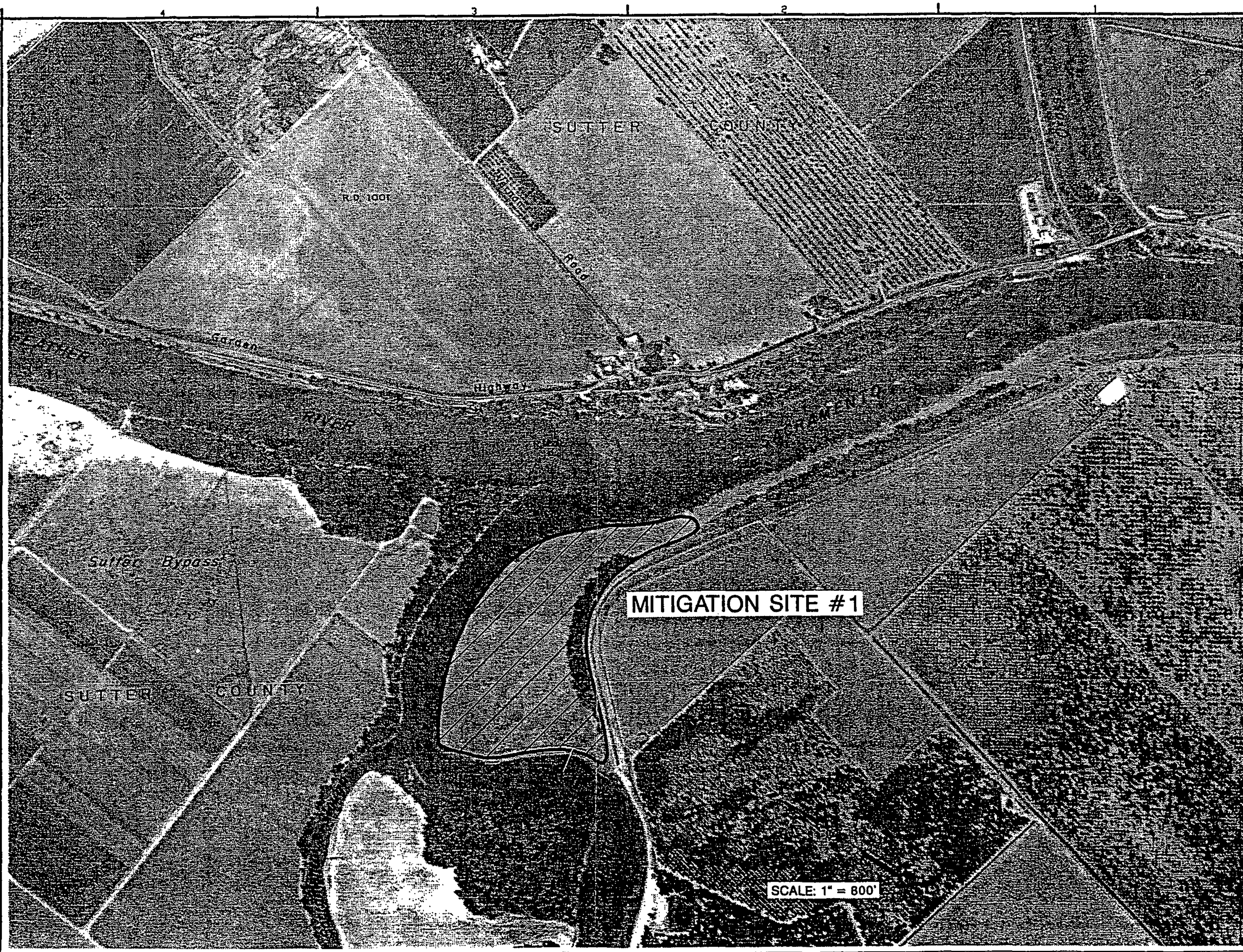
SACRAMENTO RIVER FLOOD CONTROL PROJECT
MID-VALLEY AREA PHASE III
MITIGATION SITES
LOCATION MAP

Sheet reference number:
L1
Sheet 1 of 5



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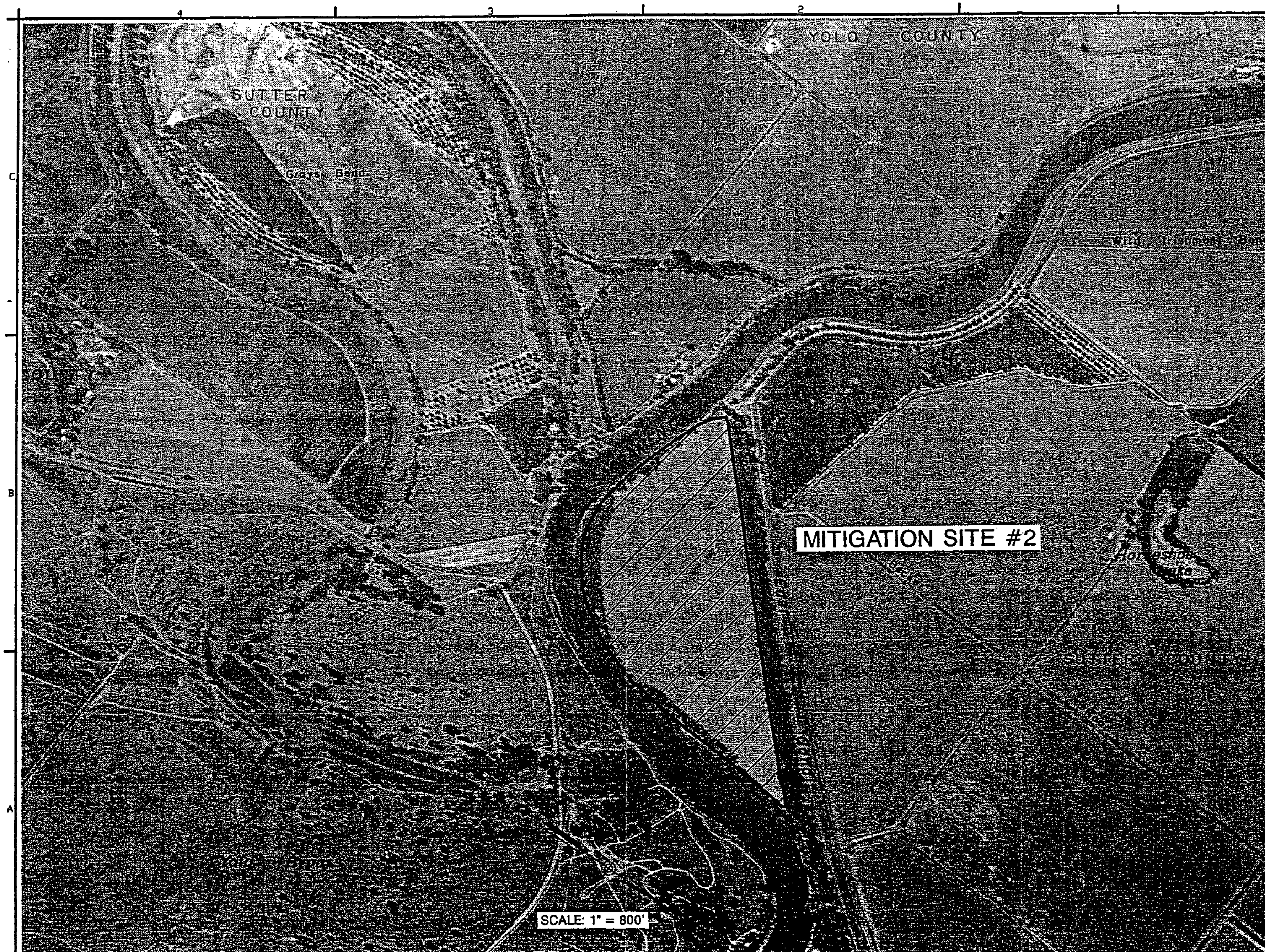
MID-VALLEY AREA, PHASE III
MITIGATION SITE #1

Sheet reference number:
L2
Sheet 2 of 5



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SACRAMENTO, CALIFORNIA

Designed by: S. JONES
Date: 26 SEPT 94

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MID-VALLEY AREA, PHASE III
MITIGATION SITE #2

Sheet reference number:
L3
Sheet 3 of 5

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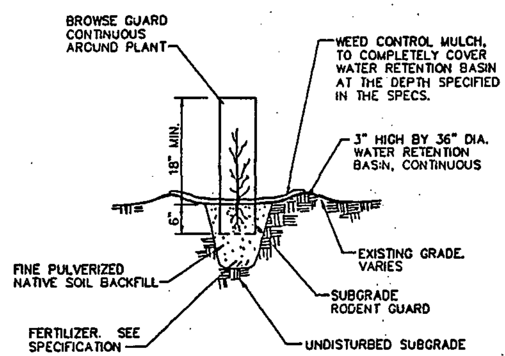
MID-VALLEY AREA, PHASE III
MITIGATION SITE #3

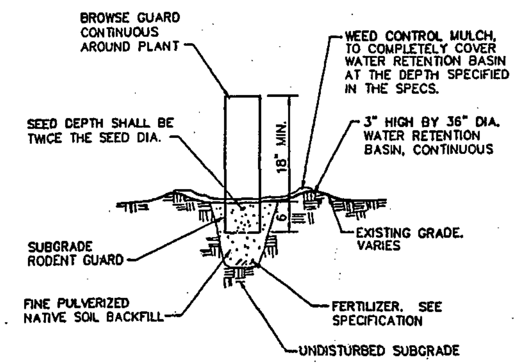
Sheet reference number:
L4
Sheet 4 of 5



NOTES:

1. SET PLANTS ROOT CROWN 1/2" ABOVE EXISTING GRADE.
2. PLANTING STOCK, UP TO ONE GALLON SIZE.
3. PLANTING PIT A MINIMUM OF TWO TIMES DIAMETER AND TWO TIMES DEPTH OF ROOTBALL. SCARIFY EDGES.

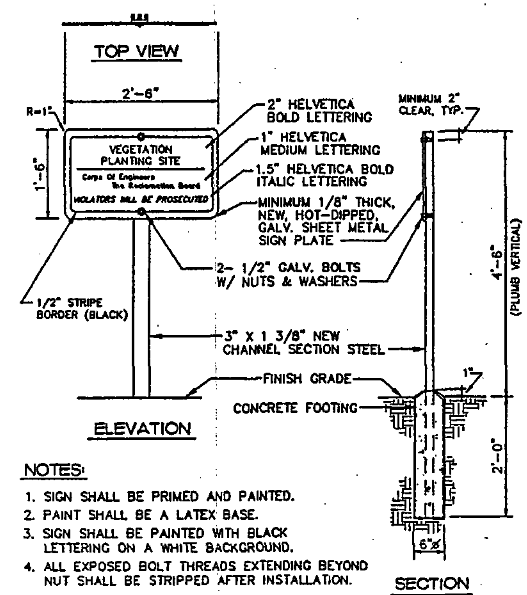
SEEDLING
NOT TO SCALE



NOTES:

1. PLANTING PIT TWO TIMES DIAMETER AND TWO TIMES DEPTH OF SUBGRADE RODENT GUARD. SCARIFY EDGES.

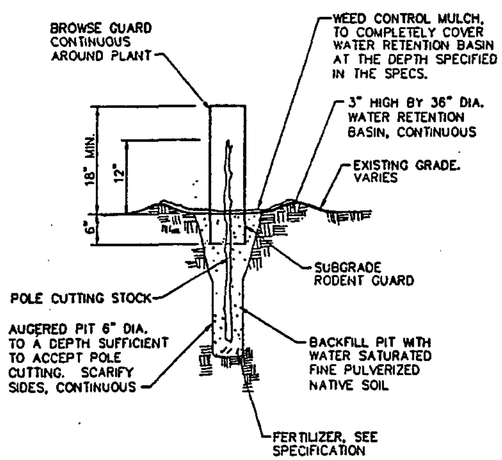
DIRECT SEED
NOT TO SCALE



NOTES:

1. SIGN SHALL BE PRIMED AND PAINTED.
2. PAINT SHALL BE A LATEX BASE.
3. SIGN SHALL BE PAINTED WITH BLACK LETTERING ON A WHITE BACKGROUND.
4. ALL EXPOSED BOLT THREADS EXTENDING BEYOND NUT SHALL BE STRIPPED AFTER INSTALLATION.

REVEGETATION SIGN
NOT TO SCALE



NOTES:

1. PLANTING STOCK; POLE CUTTING. SIZE AS PER SPECS.

POLE CUTTING
NOT TO SCALE

US Army Corps of Engineers Sacramento District

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

Designed by: S. JONES
Dwn by: R. LEE
Reviewed by: S. J.
Date: 26 SEPT 94

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SACRAMENTO RIVER FLOOD CONTROL PROJECT
MID-VALLEY AREA, PHASE III

MITIGATION DETAILS

Sheet reference number:
L5
Sheet 5 of 5

APPENDIX F

CESPK-RE-CP (405-10f) 4 August 1995

MEMORANDUM FOR Chief, Engineering Division, ATTN: CESPK-ED-A (Shanching Hsia)

SUBJECT: Real Estate Plan for Mid-Valley

As instructed by Mr. Phil Lee, project manager, the enclosed real estate report has been modified to reflect a change in reporting mitigation land requirements. The real estate map plates have been delivered under separate cover. Should you have any questions regarding this report, or seek information concerning real estate issues, please contact Elizabeth Youn at 7013 or 6809.

Encl

MARVIN D. FISHER
Chief, Real Estate Division

CC: (w/o map plates)
CESPK-PM-C (Phil Lee)

APPENDIX F

Sacramento River Flood Control Project

Mid-Valley Area Levee Reconstruction
Real Estate Plan

1. **Introduction**. This Appendix will describe the real estate needed to reconstruct Sacramento River Flood Control Project levees to the level of protection as originally designed. The Sacramento River Flood Control Project was authorized by the Flood Control Act of 1917. Construction began in 1918, and various project components were completed between 1952 and 1968.

The Conference Report accompanying the Energy and Water Development Appropriation Act, 1987 (Public Law 99-591) included funds under Operation and Maintenance, General Appropriation, Inspection of Completed Works, for an evaluation of the flood control system for the Sacramento River and its tributaries.

2. **General Description of Real Estate Requirements**. The greater Mid-Valley project begins at the southern portion of the Yolo Bypass north of Highway 80 in Yolo County, and moving northwesterly, terminates just south of the Tisdale Bypass in Sutter County. The area is rural and primarily used for agriculture. Agricultural land uses range from dry land use in the low elevation areas of the Sutter and Yolo Bypass region, to more intense land benefits of row crop, orchards, and agricultural/residential use along the Sacramento and Feather Rivers.

Lands areas to be acquired in support of the project are nonconnective parcels along the Sacramento River, Feather River, and the Sutter and Yolo Bypass area, in Sutter and Yolo Counties. Areas examined include: (1) Area #1, Robbins/Knights Landing, Sites 1 through 13; (2) Area #2, Verona, Sites 16 through 20, and (3) Area #3, Elkhorn, Sites 14 and 15.

Mitigation Sites for fish and wildlife consist of two, nonconnective land areas located within the Sutter Bypass, Sutter County. Agricultural row crop is the primary use for these lands. Mitigation Site #1 contains approximately 70.4 acres of land, and Site #2 contains approximately 4.5 acres of land.

The non-Federal sponsor and/or its partners have sufficient rights in the existing levees to permit the work contemplated for this project. The following estimated acreage requirements are those acres needed for the reconstruction project which are beyond the toe of the existing levees. It has also been assumed

that the non-Federal levee easements were acquired for the purposes of a prior project built in cooperation with the Corps, therefore, the cost estimate does not include the value of those lands.

Mid-Valley Project Real Estate Requirements			
Estate	**Robbins/Knights Landing Area #1**	**Verona Area #2**	**Elkhorn Area #3**
Fee (acres)	74.9	0	0.0
Levee Easement (acres)	54.4	6.6	41.6
Temp Const Easement (acres/2 yrs)	29.6	4.0	16.0
Temp Borrow Easement (acres/2 yrs)	123.4	0.0	0.0
Temp Staging Areas (acres/ 2 yrs)	12.2	5.8	9.8
Number of Parcels	59	15	19
Number of Ownerships	26	7	8
Number of Relocations	0	0	0

3. **Estates**. The non-Federal sponsor will acquire the minimum interests in real estate which will support the construction, operation and maintenance of the project. The estates to be acquired, as stated above, are the standard estates prescribed by Corps regulations. The estate language used by the non-Federal sponsor differs to a small degree from the language of the Corps standard estates. Prior to the start of negotiations, the Corps will review the non-Federal sponsor's estate language to ensure that (a) there will be no impediment to the construction, operation or maintenance of the project; and (b) the sponsor's estate language does not enhance the minimum rights needed such that an appreciable increase in fair market value may result.

4. **Public Law 91-646 Relocations**. The project does not involve the application of Public Law 91-646 and Public Law 100-17 in the relocation of persons and personal property.

5. **Sponsor's Ability to Acquire**. The Reclamation Board, through the Department of Water Resources (DWR), has the ability to acquire the necessary rights in real estate for the flood control project. DWR has the power of eminent domain pursuant to Water Code Sections 8590, et seq., and Code of Civil Procedures Sections 1230.010. et seq. DWR has an experienced right of way staff which has acquired lands for several flood control projects

since implementation of the Water Resources Act of 1986. The experience of working on other cost-shared projects with the Corps will facilitate the successful acquisition of lands for this project.

6. **Baseline Cost Estimate**. The Gross Appraisal was prepared by Leslie Tornatore, Corps Staff Appraiser, on 12 July 1995. Costs are estimated at October 1995 price levels. All lands needed for the project (excluding lands which were previously contributed to a Federal project), regardless of ownership, have been estimated at fair market value.

The differences between State and Federal appraisal rules have been considered and are not expected to have any appreciable impact on the estimated real estate costs.

The baseline cost estimate includes acquisition and administrative costs. The non-Federal acquisition costs were estimated by the non-Federal sponsor. The Federal costs of monitoring the acquisitions, certifying for construction and crediting the sponsor were estimated by Real Estate Division.

Mid-Valley Project Baseline Cost Estimate			
Type of Cost	**Robbins/Knights Landing Area #1**	**Verona Area #2**	**Elkhorn Area #3**
Non-Federal Acquisition	$1,023,300	$294,200	$294,200
Federal Review	$136,400	$57,500	$58,100
Relocation Assistance	$0	$0	$0
Lands and Improvements	$425,500	$44,300	$130,000
Totals	**$1,585,200**	**$396,000**	**$473,800**

7. **Maps**. The proposed project real estate limits follow on Map Plates 1 through 17.

8. **Mineral Activity**. There was evidence of mineral rights on Site 11, (Area #1, Robbins/Knights Landing), as a gas well appeared to be outside the take area. However, since it is not known at this level of land cost analysis if the gas well is functioning or if it has been capped, it is not considered to contribute significant value to the site.

9. **Facility and Utility Relocations**. Where required, provisions will have to be made for the relocation of existing utilities. The project engineer has not identified real estate requirements

for utility relocations. No land cost estimates for utility relocation have been considered in this report.

Further investigation will be made regarding the ownership of both personal and real property rights in the project right of way. The non-Federal sponsor, will be responsible for the relocation of all utilities if determined any existing utilities must be relocated or modified.

10. **<u>Hazardous, Toxic, and Radioactive Waste (HTRW)</u>.** No evidence of contamination or toxic waste has been observed on project lands. Should any Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) contamination, however, be found to exist on any lands necessary for the project, the local sponsor would be responsible for any and all necessary clean-up and responsible costs, to include the costs of any studies and investigations necessary to determine an appropriate response to the contamination. Such costs are not considered a part of the total project costs.

11. **<u>Acquisition Schedule</u>.** The non-Federal sponsor prepared the following acquisition schedule:

REAL ESTATE ACQUISITION SCHEDULE				
MID-VALLEY RECONSTRUCTION	**COE Start**	**COE Finish**	**NFS Start**	**NFS Finish**
Receipt of preliminary drawings from Engineering/PM		10/95		
Receipt of final drawings from Engineering/PM		11/96		
Execution of PCA	1/97			
Formal transmittal of final ROW drawings & instruction to acquire LERRD		1/97		1/97
Conduct landowner meetings			10/95	12/96
Prepare/review mapping & legal descriptions			1/97	4/97
Obtain/review title evidence			10/95	1/96
Obtain/review tract appraisals			1/97	5/97
Conduct negotiations			5/97	12/97
Perform closing			12/97	1/98
Prepare/review condemnations			10/97	12/97
Perform condemnations			12/97	2/98
Obtain possession			2/98	3/98
Complete/review PL 91-646 benefit assistance			N/A	
Conduct/review facility and utility relocations			N/A	
Certify all necessary LERRD is available for construction				3/98
Prepare and submit credit requests			4/98	7/98
Review/approve or deny credit requests	5/98	10/98		
Establish value for creditable LERRD in F&A cost accounting system	9/98	2/99		

NFS - Non-Federal Sponsor
COE - Corps of Engineers

MID-VALLEY AREA

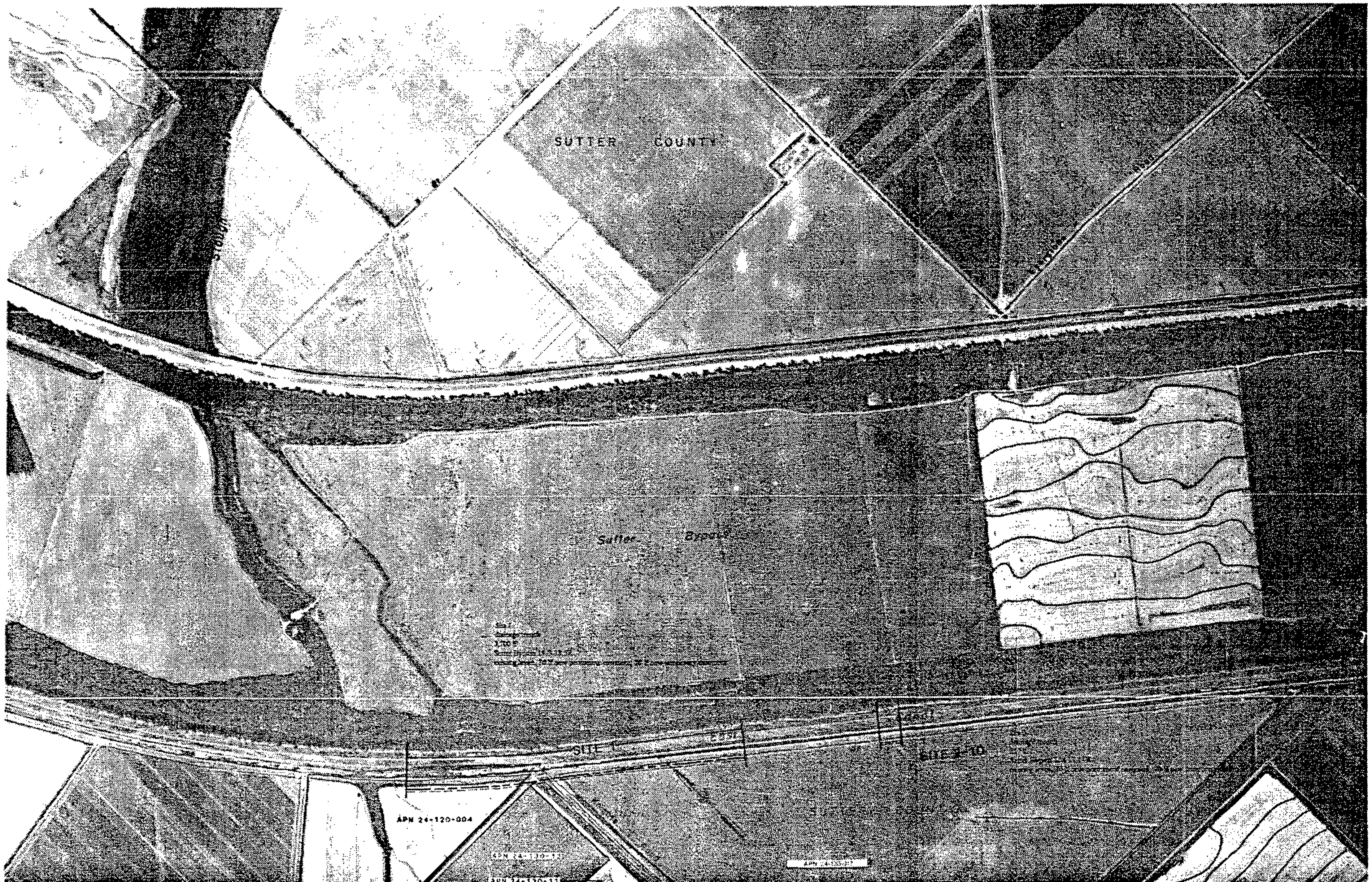
FLOOD CONTROL SYSTEM

LEGEND

PERMANENT EASEMENT
TEMPORARY EASEMENT
PROPERTY LINE
MITIGATION SITE
BORROW SITE
STAGING AREA

NOTE: THE INFORMATION ON THIS MAP IS BEING FURNISHED AS A CONVENIENCE TO LOCATE THE PROJECT LANDS WITH RELATION TO ADJOINING STREETS AND OTHER PHYSICAL FEATURES.
ALL PARCEL LINES HAVE BEEN INTERPOLATED FROM COUNTY ASSESSOR PARCEL MAPS.
PROPERTY LINES MUST BE VERIFIED BY A LAND SURVEY IN ORDER TO DEVELOP LEGAL DESCRIPTIONS THAT ARE SUFFICIENT FOR LAND PURCHASES.

			SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION	MID-VALLEY AREA	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 1 OF 15



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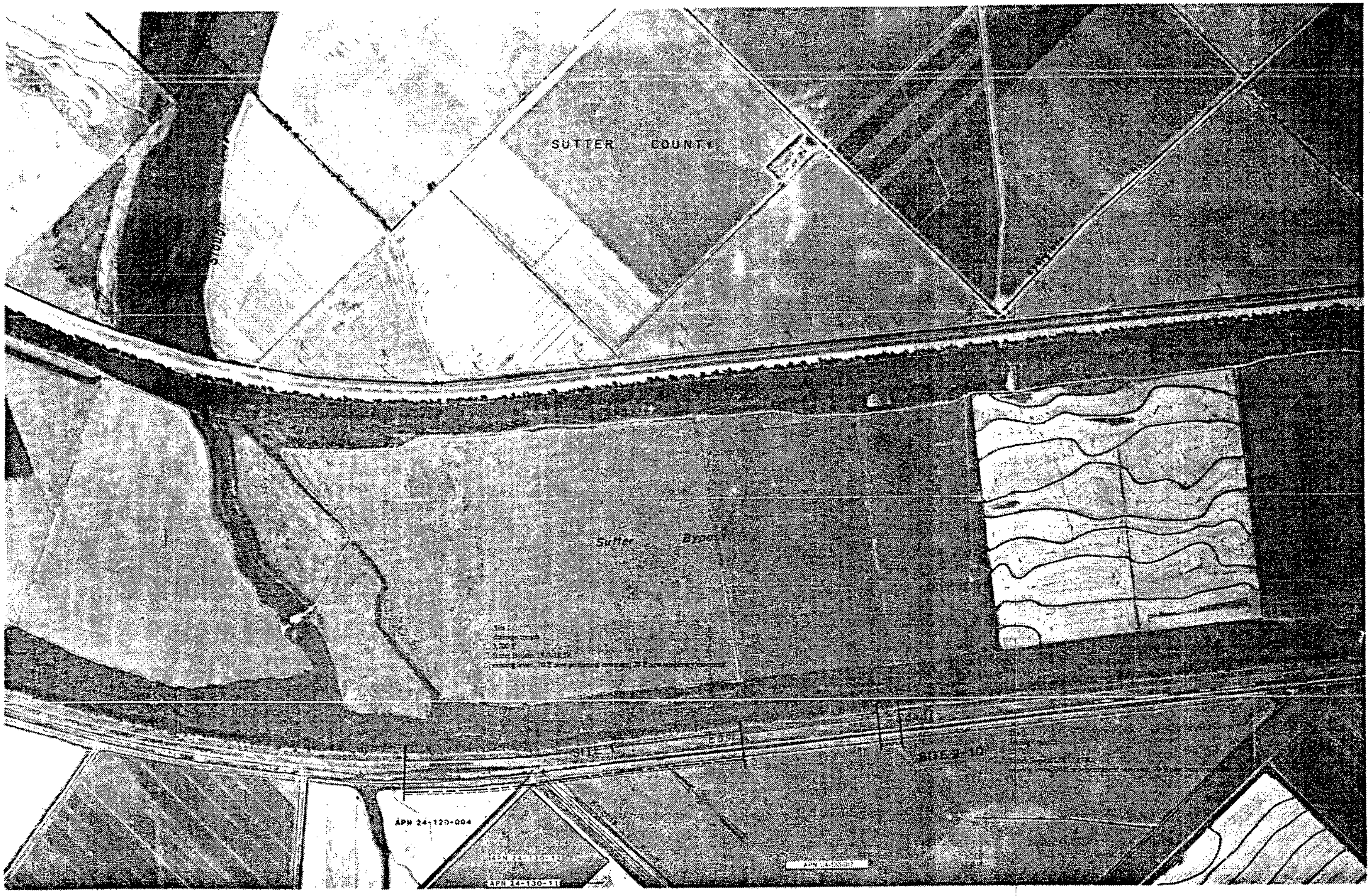

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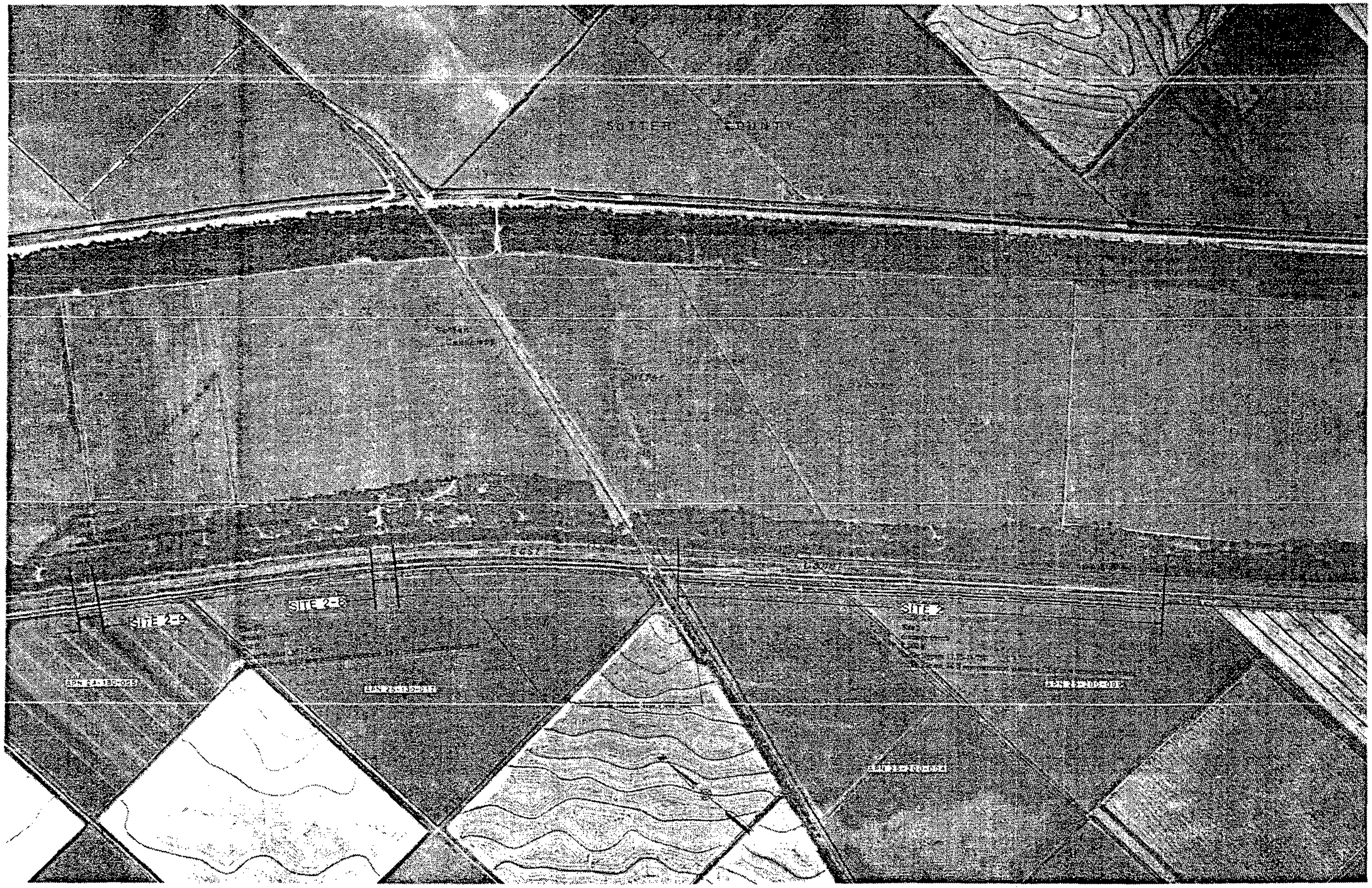
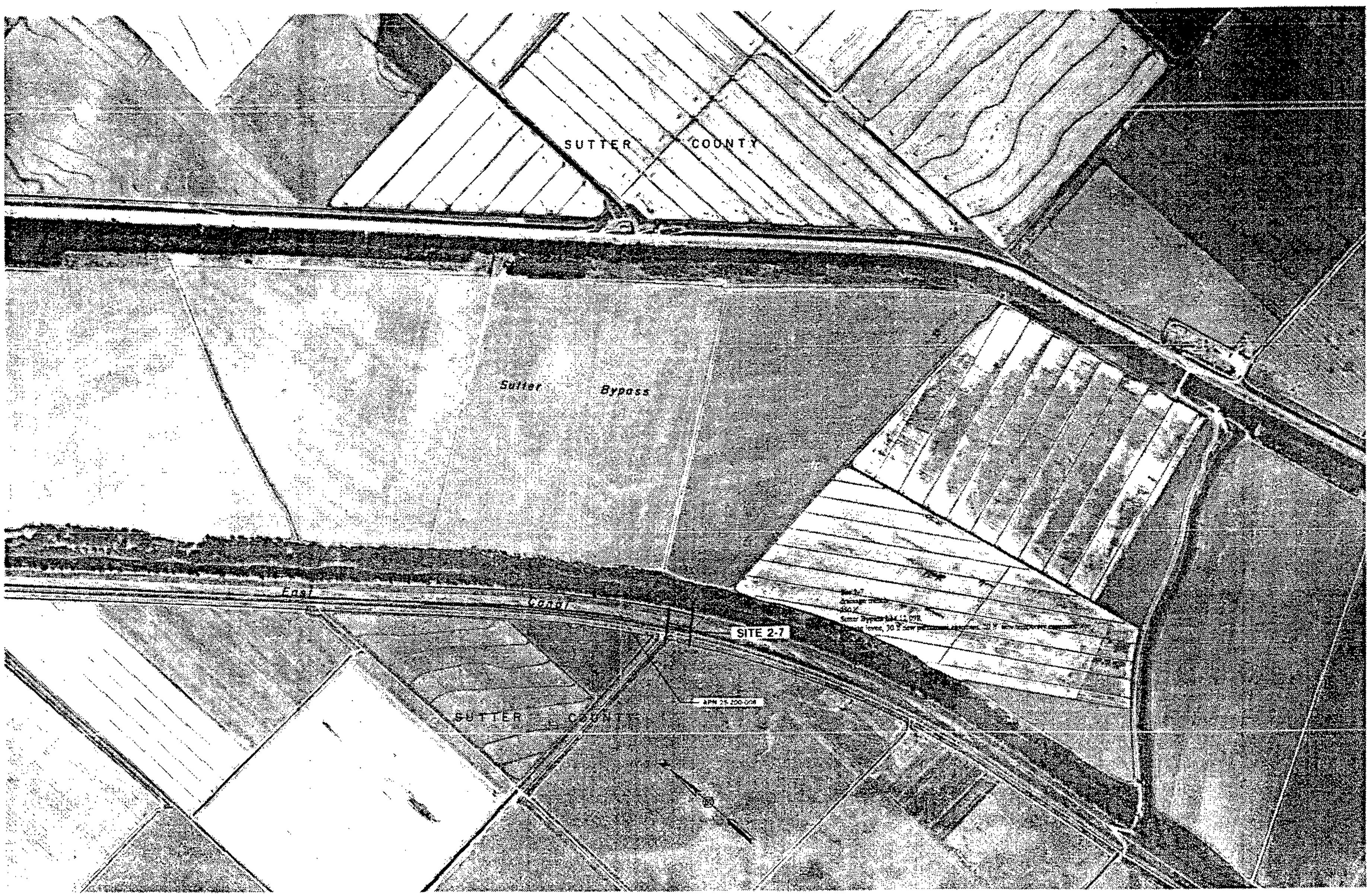


SCALE IN FEET 400 200 0 400 800			SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION	MID-VALLEY AREA	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 3 OF 18



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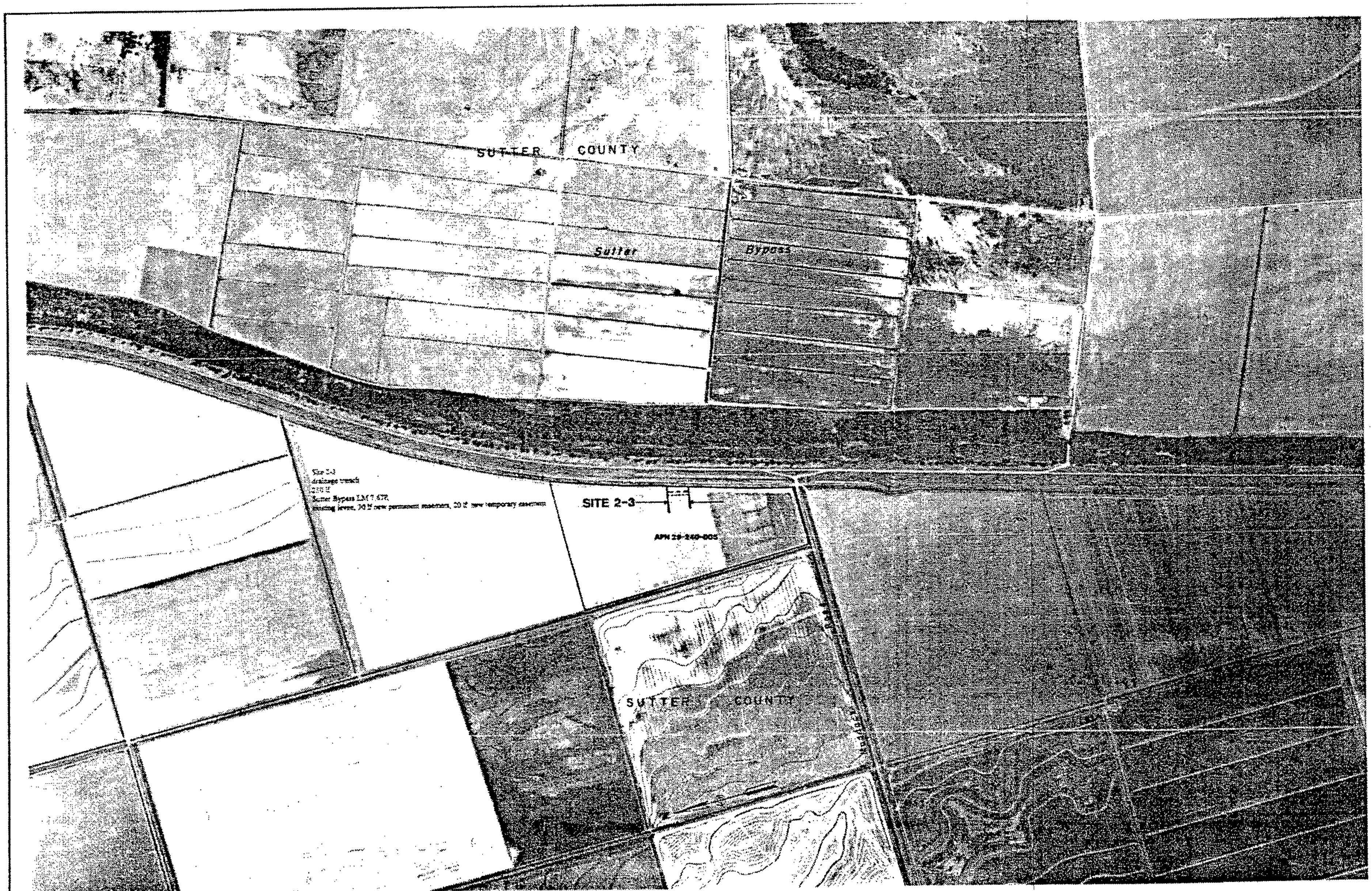
SCALE IN FEET 400 200 0 400 800	ENLARGED FROM EXP. SA-18-12	DATE OF PHOTOGRAPHY 10-18-91 FILM CAN NO. 955	SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION	MID-VALLEY AREA	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 35 OF 16



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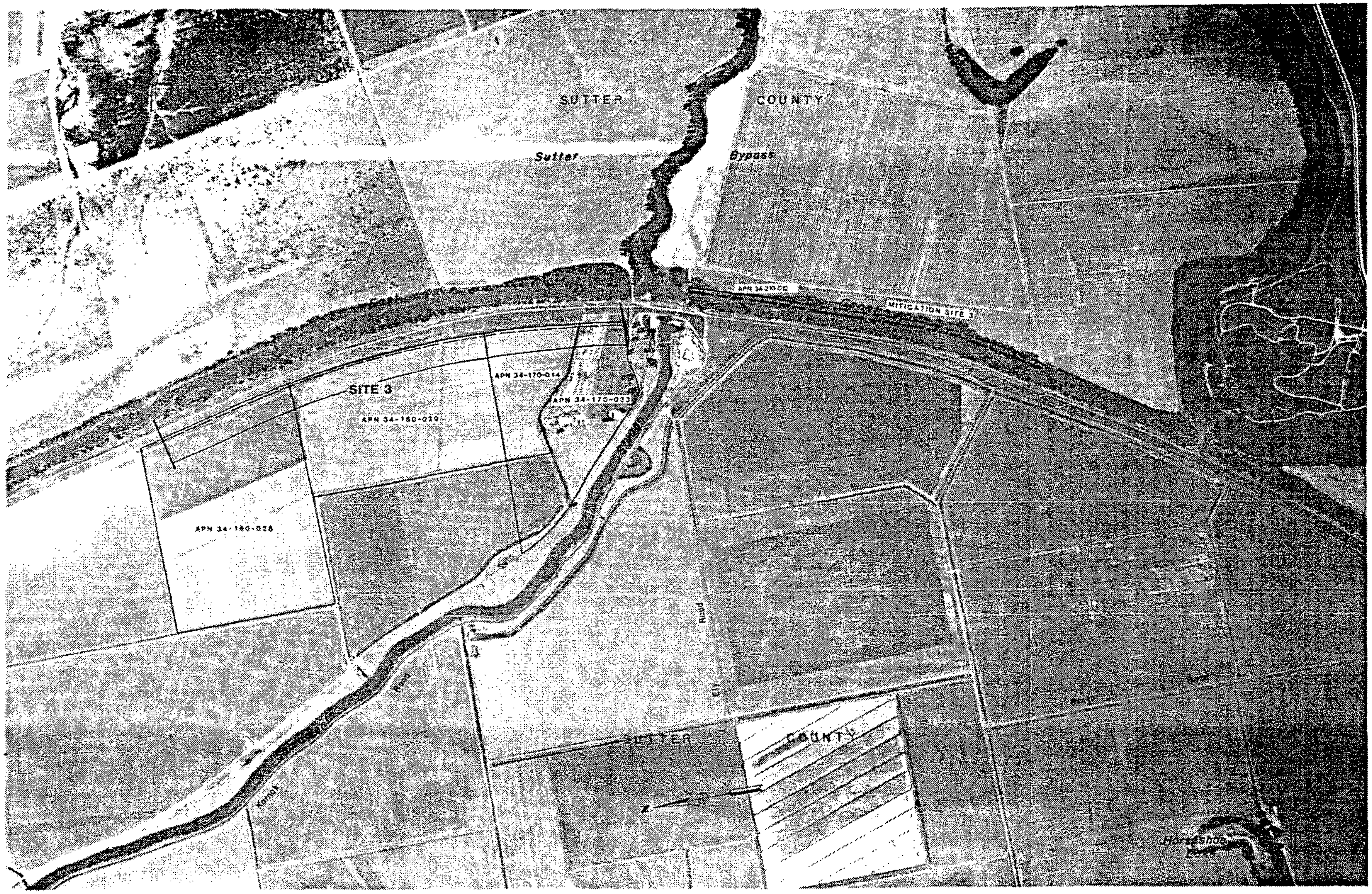
SCALE IN FEET 400 200 0 400 800	ENLARGED FROM EXP 04-24-54	DATE OF PHOTOGRAPH / FILM CAN #	SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION	MID-VALLEY AREA	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 3D OF 16

SCALE IN FEET 400 200 0 400 800	ENLARGED FROM EXP. DA 30-29	DATE OF PHOTOGRAPH 10-14-91 FILM CAN #1 965	SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION	MID-VALLEY AREA	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 4 OF 16

SCALE IN FEET 400 200 0 400 800	ENLARGED FROM EXP. 34-20-29	DATE OF PHOTOGRAPH 10-14-81 FILM CAN NO. 965	SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION	MID-VALLEY AREA	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 4 OF 16



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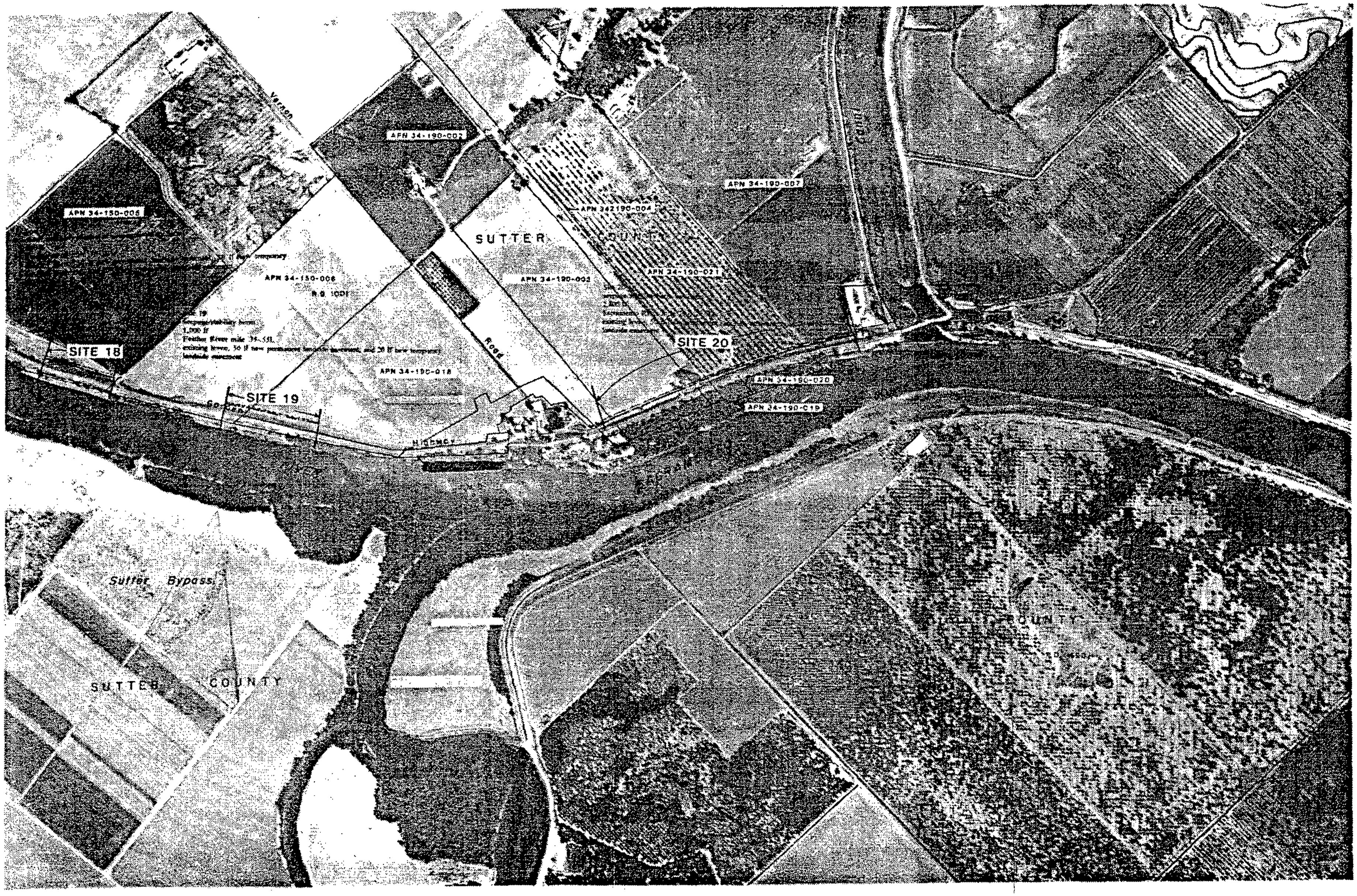

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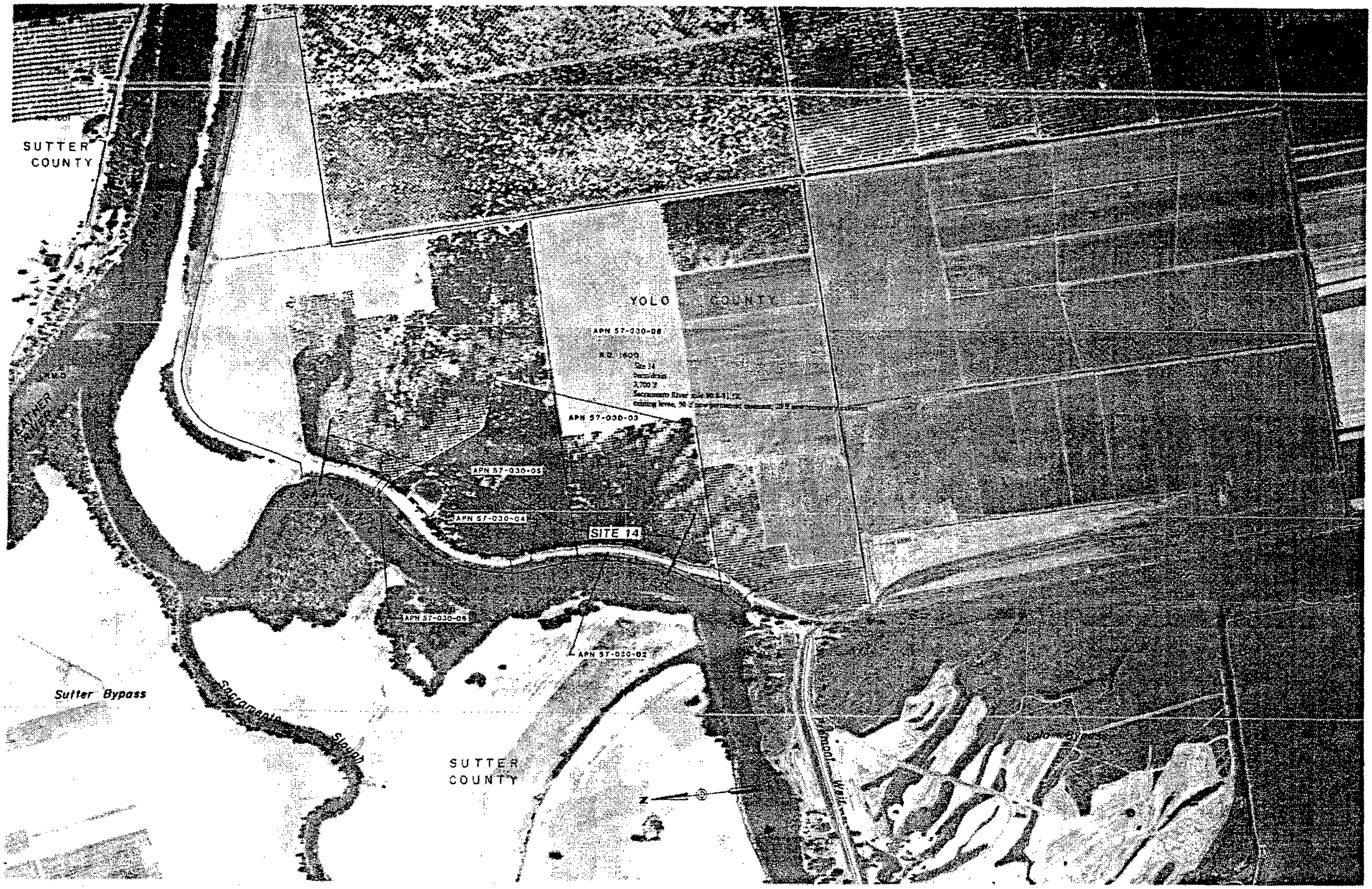

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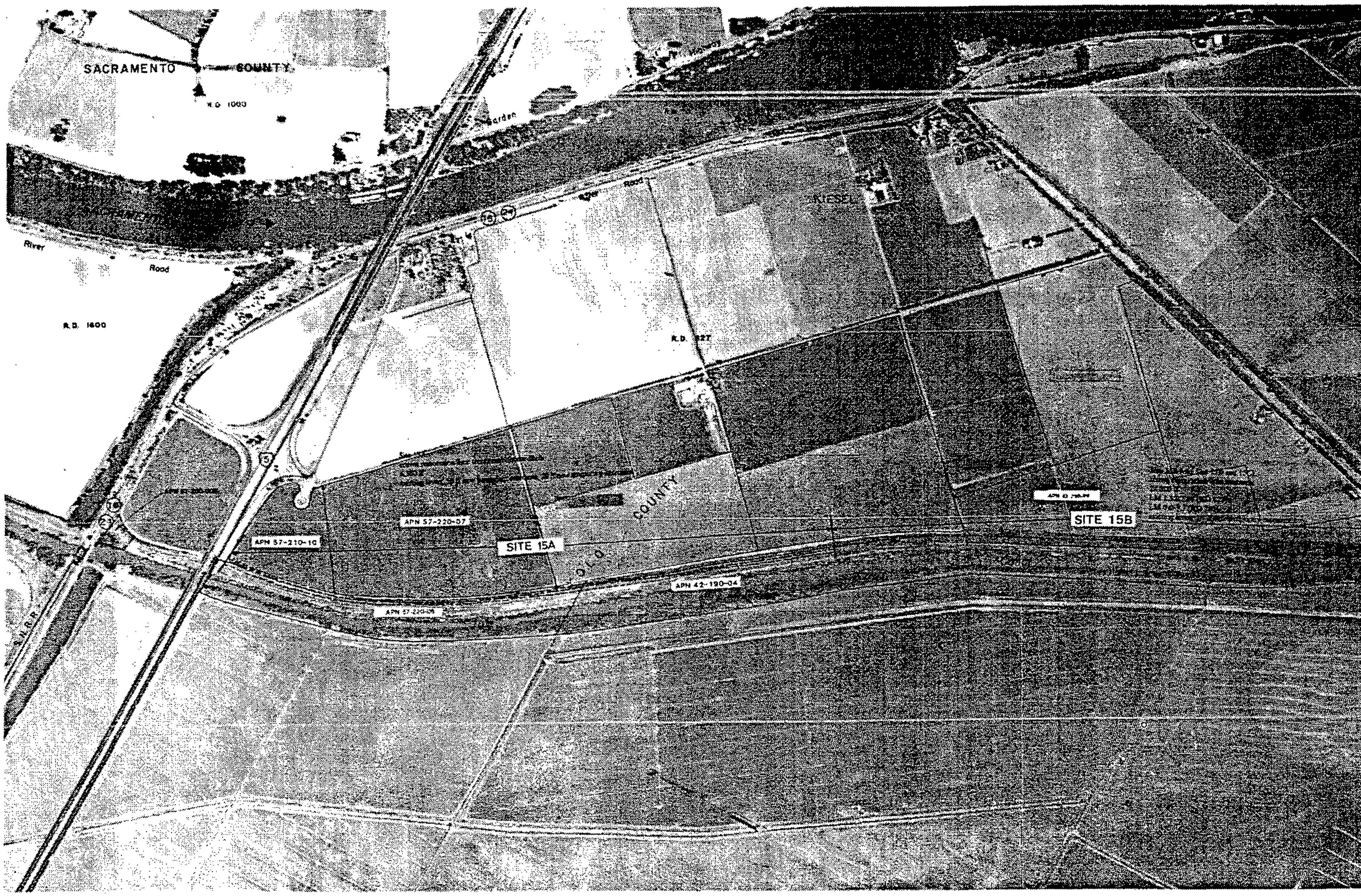

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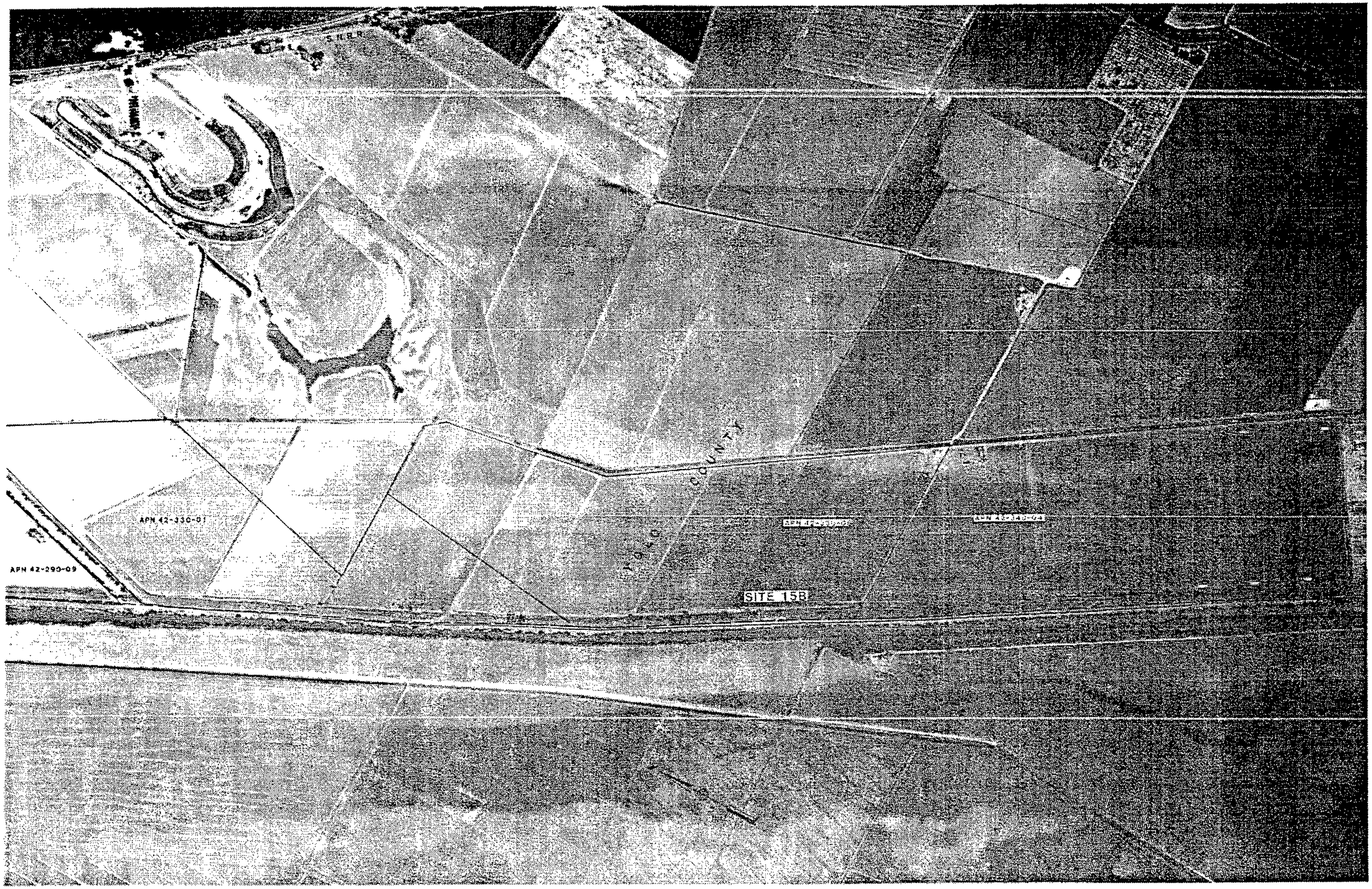
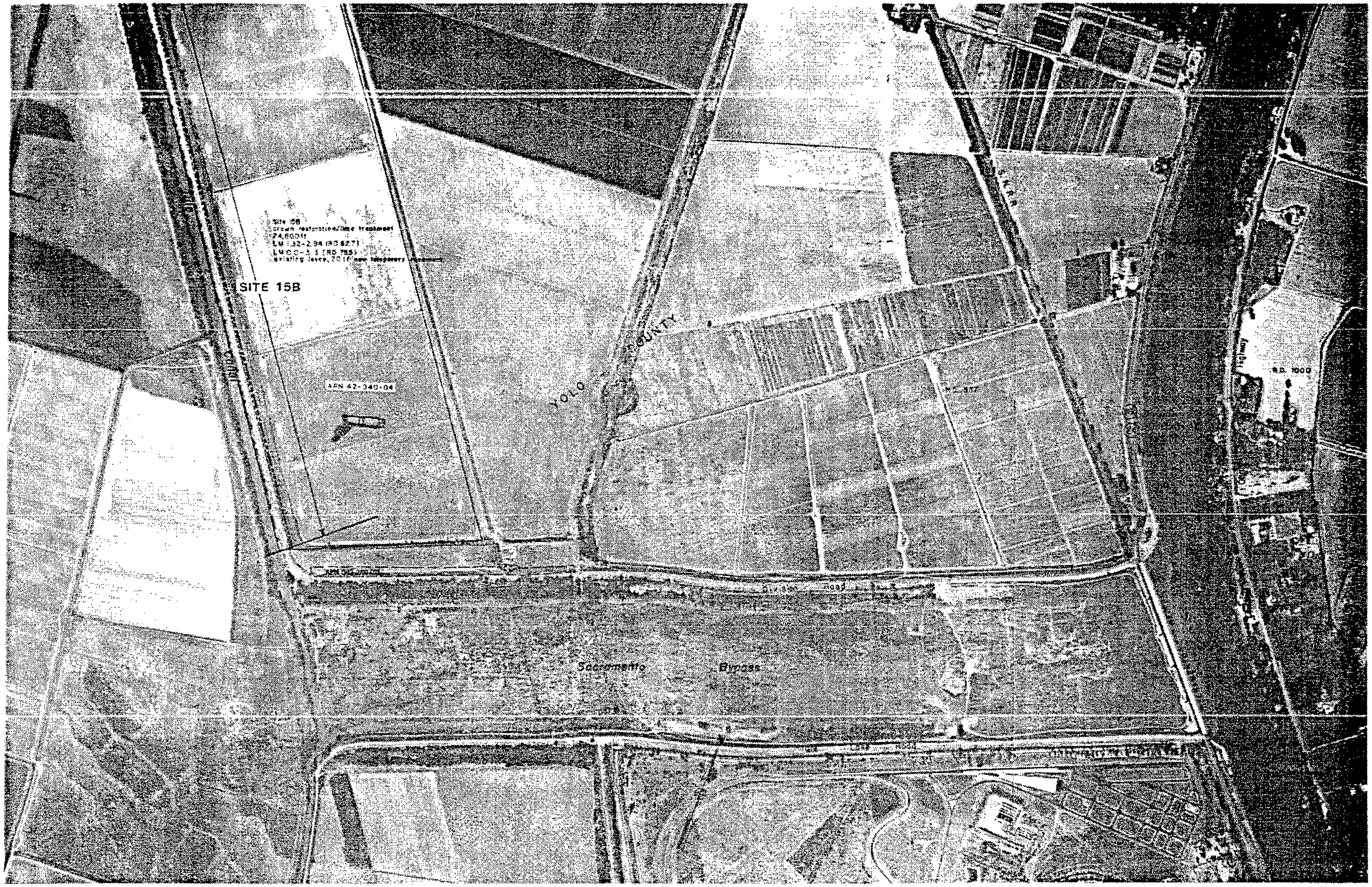
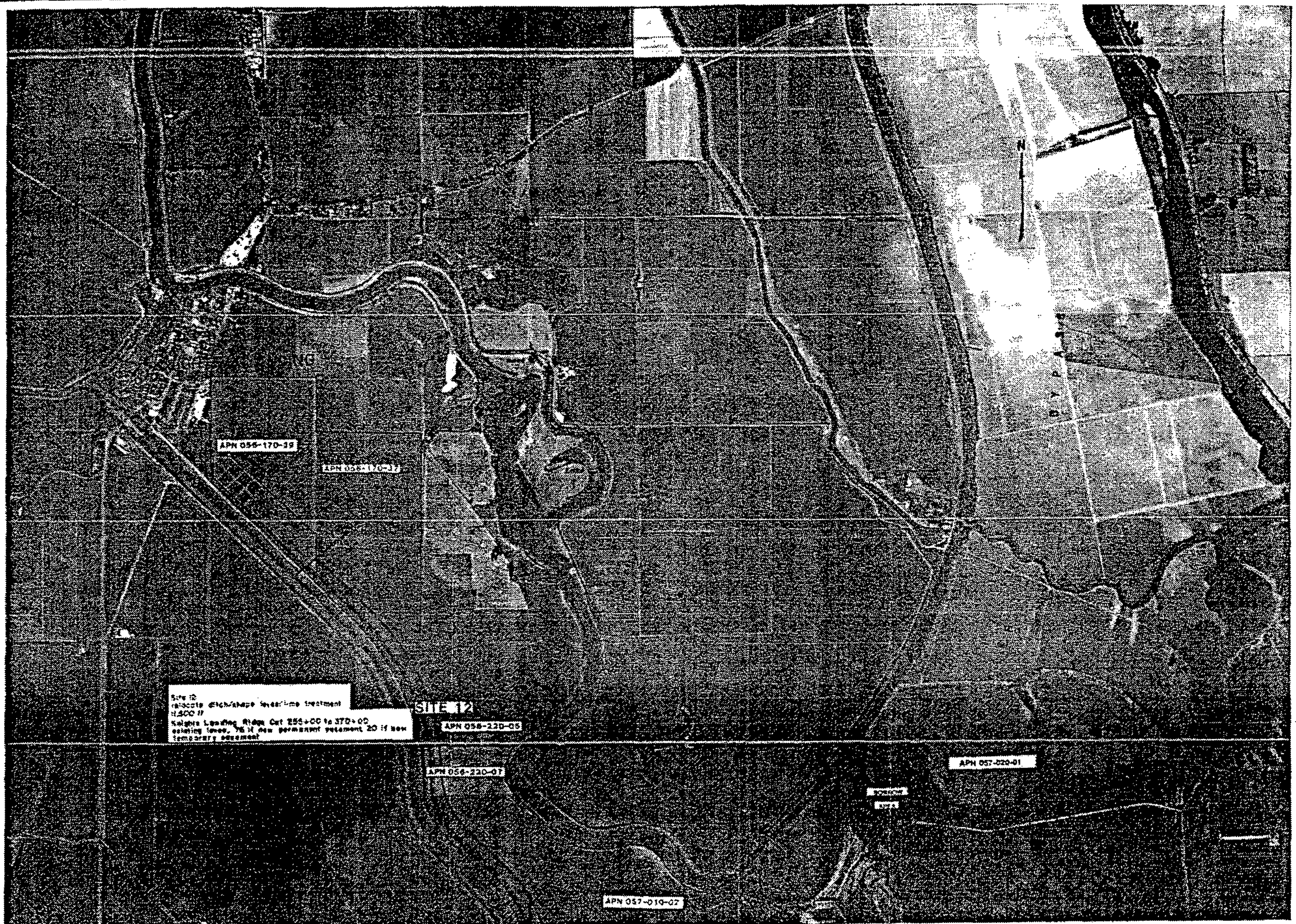


SCALE IN FEET 400 200 0 400 800	ENLARGED FROM	DATE OF PHOTOGRAPHY	SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION	MID-VALLEY AREA	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 9 OF 16



SCALE IN FEET 400 200 0 400 800			SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION	MID-VALLEY AREA	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 10 OF 16



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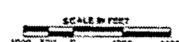
1000 500 0 1000 2000

SACRAMENTO VALLEY FLOOD CONTROL SYSTEM	SACRAMENTO RIVER AND TRIBUTARIES FREEPORT TO SUTTER BUTTE	U.S. ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT REAL ESTATE DIVISION GENERAL DESIGN MEMORANDUM	JANUARY 1995 SHEET 11 OF 16



SACRAMENTO VALLEY
FLOOD CONTROL SYSTEM

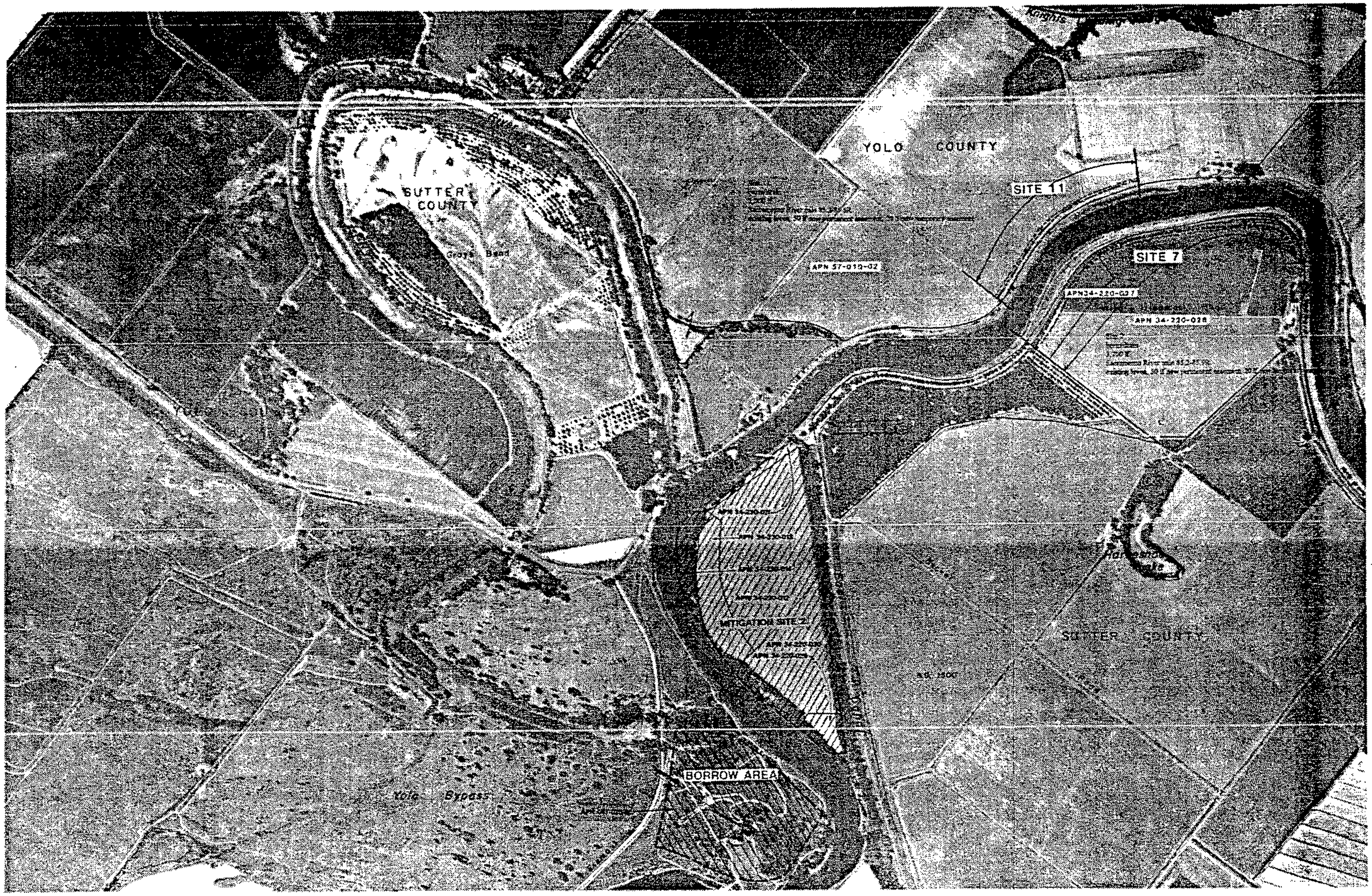
SACRAMENTO RIVER
AND TRIBUTARIES
FREEPORT TO SUTTER BUTTE

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
REAL ESTATE DIVISION

GENERAL DESIGN MEMORANDUM

JANUARY 1995

SHEET 12 OF 16



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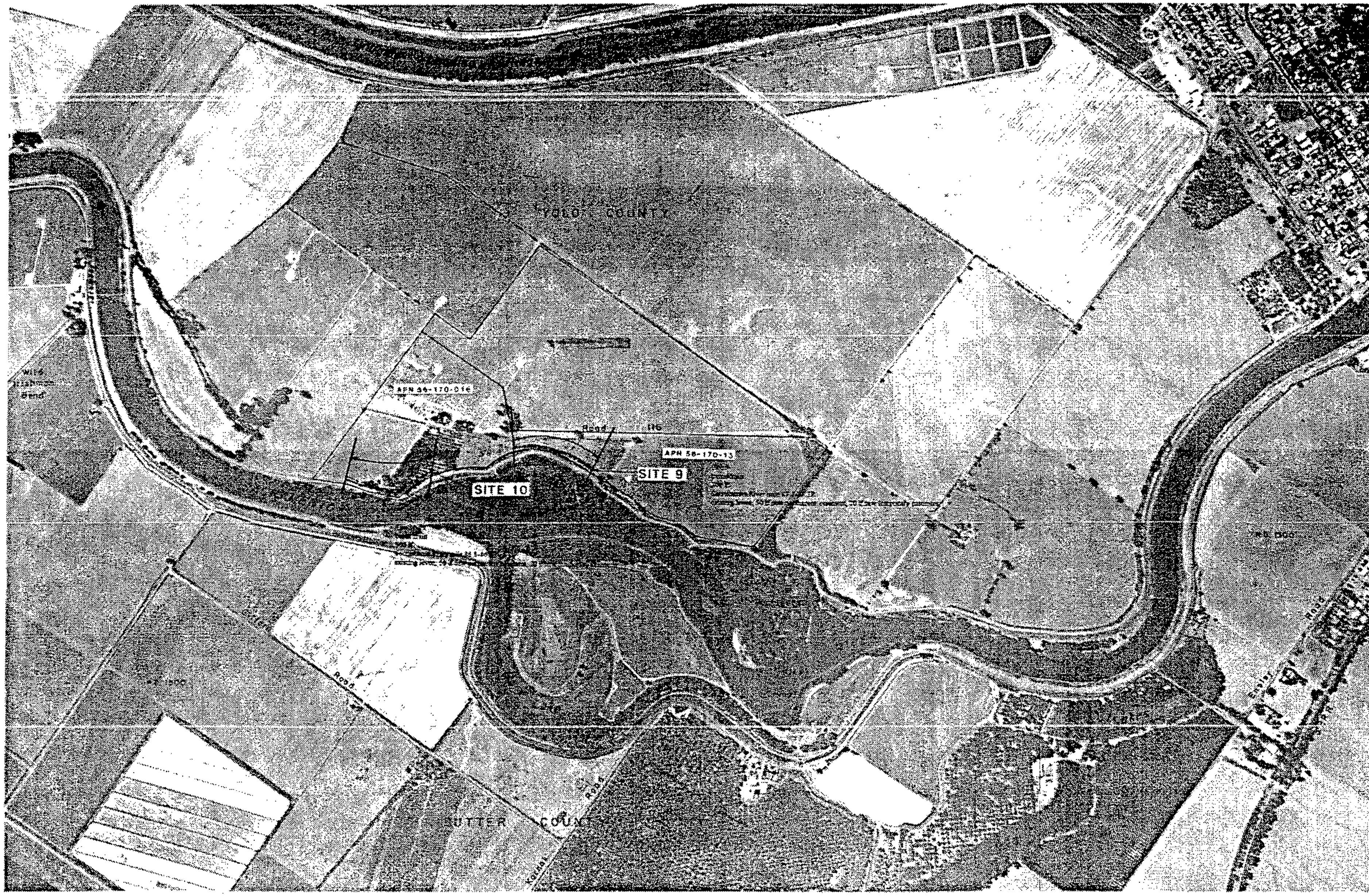

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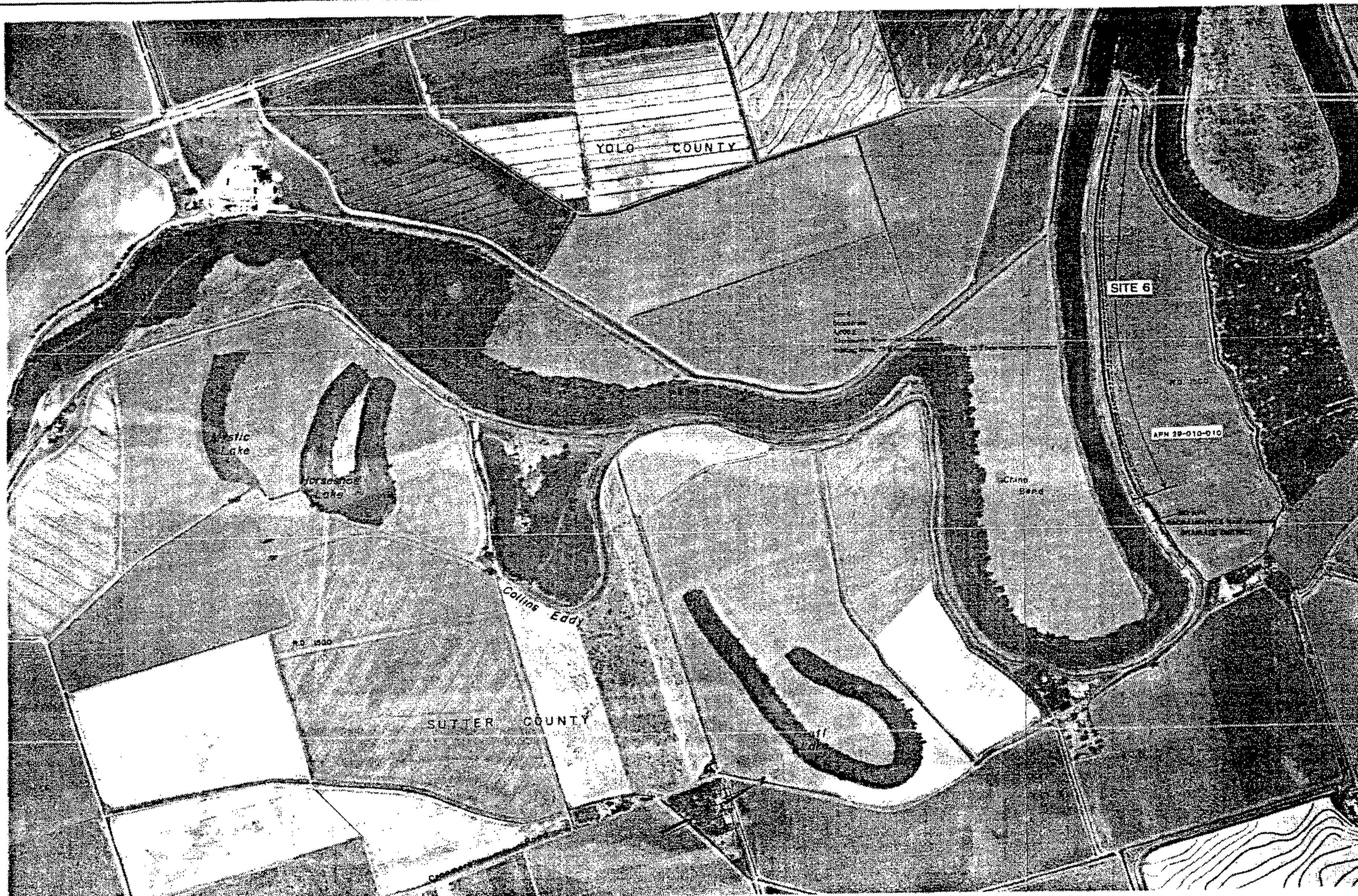

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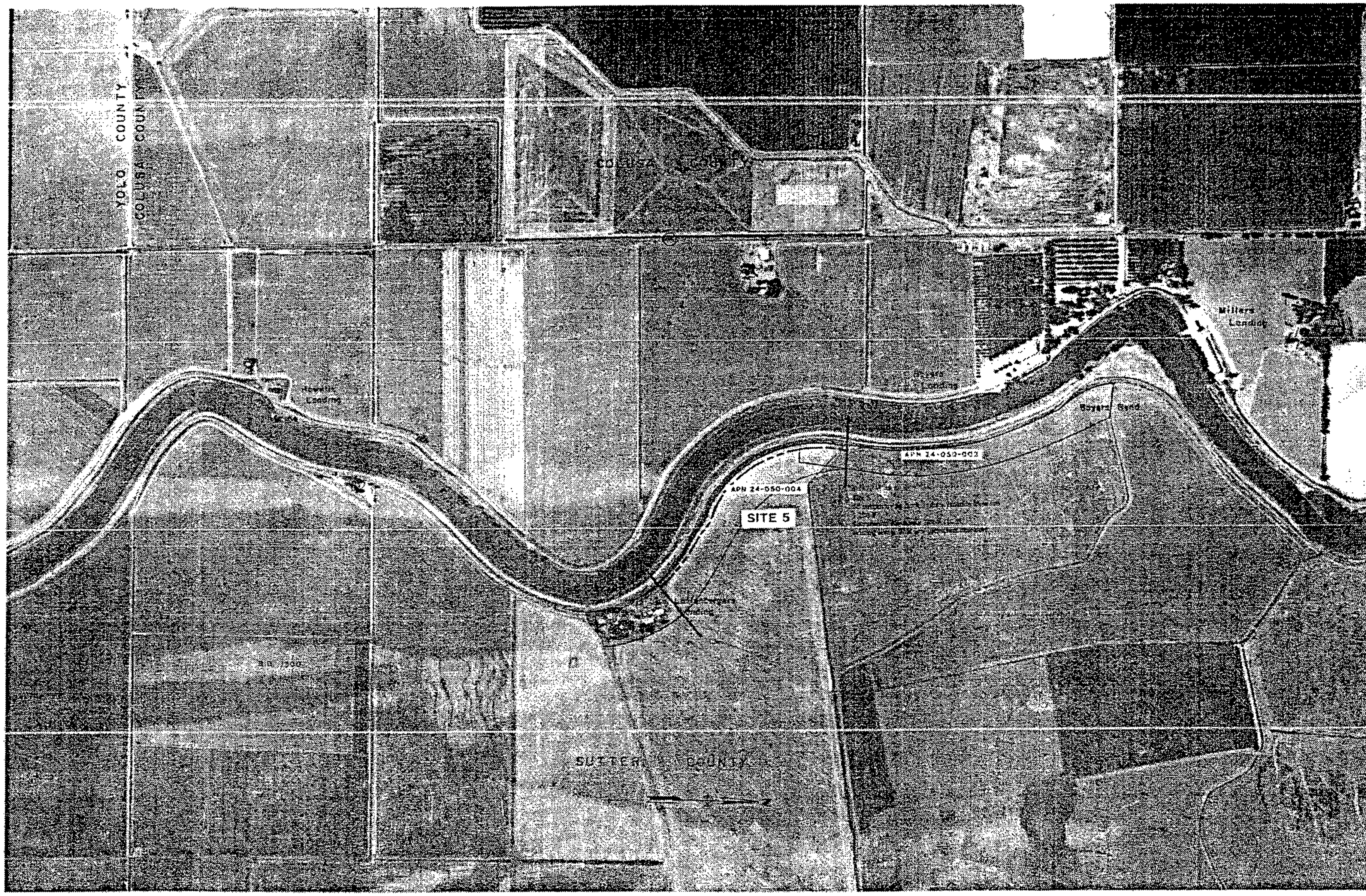

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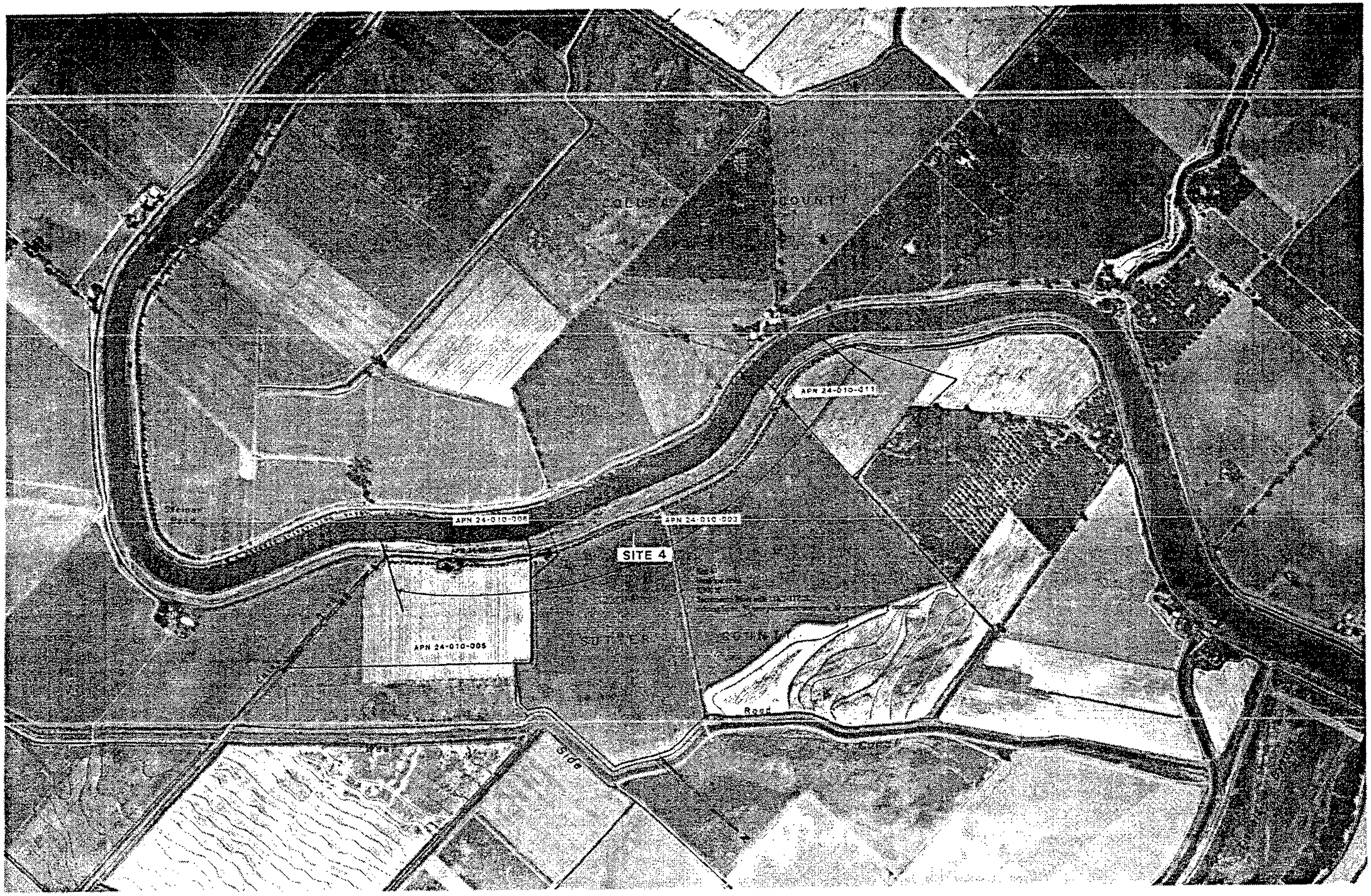

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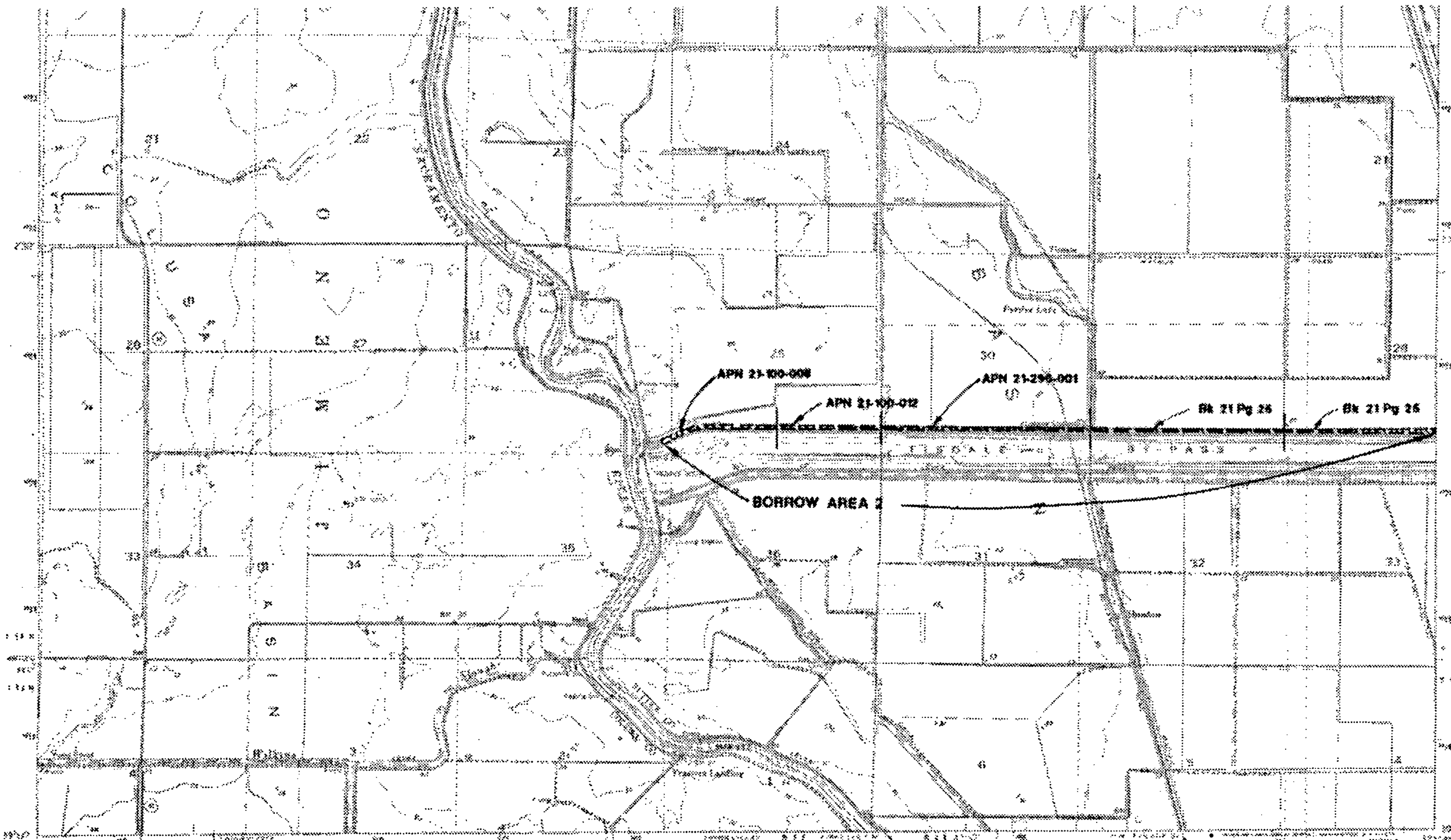

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT
REAL ESTATE DIVISION

REAL ESTATE

MID-VALLEY AREA

REAL ESTATE REQUIREMENTS

GENERAL DESIGN MEMORANDUM

APPENDIX G

Mid-Valley Levee Restoration
Area 1

Designed By: US Army Corps of Engineers
Estimated By: CESPK-ED-C

Prepared By: S. C. Fong

Preparation Date: 07/14/95
Effective Date of Pricing: 07/14/95

Sales Tax: 7.75%

SUMMARY REPORTS — SUMMARY PAGE

No Detailed Estimate...

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - (Unused) **

	QUANTITY	UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
02 RELOCATIONS										
0203 CEMETERIES,UTILITIES,& STRUCTURE										
020399 Associated General Items										
02039902 Site Work										
0203990201 Relocate 4'x6'x6'Concrete Distr.										
0203990201 1 Structural Excavation	28.00	CY	953	0	0	0	0	0	953	34.04
0203990201 2 Structural Backfill	28.00	CY	735	0	0	0	0	0	735	26.23
0203990201 3 Relocate Dist. Box	1.00	EA	1,635	0	0	0	0	0	1,635	1635.42
TOTAL Relocate 4'x6'x6'Concrete Distr.	1.00	EA	3,323	0	0	0	0	0	3,323	3323.16
0203990202 Relocate V Shape Irrig. Ditch										
0203990202 3 Excavation,	1222.00	CY	9,865	0	0	0	0	0	9,865	8.07
0203990202 4 Compaction,	1222.00	CY	5,290	0	0	0	0	0	5,290	4.33
TOTAL Relocate V Shape Irrig. Ditch	11000.00	LF	15,155	0	0	0	0	0	15,155	1.38
TOTAL Site Work			18,478	0	0	0	0	0	18,478	
TOTAL Associated General Items			18,478	0	0	0	0	0	18,478	
TOTAL CEMETERIES,UTILITIES,& STRUCTURE			18,478	0	0	0	0	0	18,478	
TOTAL RELOCATIONS			18,478	0	0	0	0	0	18,478	
11 LEVEES AND FLOODWALLS										
1101 LEVEES										
110199 Associated General Items										
11019902 Site Work										
11019902 1 Clearing and Grubbing										
11019902 1 1 Vegetation	28.50	ACR	6,853	0	0	0	0	0	6,853	240.45
11019902 1 3 Load, Haul & disposal 10mile	8493.00	CY	144,196	0	0	0	0	0	144,196	16.98
11019902 1 4 Cut Trees and Disposed	627.00	EA	129,332	0	0	0	0	0	129,332	206.27
11019902 1 5 Remove Stumps	627.00	EA	75,160	0	0	0	0	0	75,160	119.87
TOTAL Clearing and Grubbing	28.50	AC	355,540	0	0	0	0	0	355,540	12475.10

** PROJECT OWNER SUMMARY - (Unused) **

	QUANTITY UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
11019902 2 Stripping	15110.00 CY	101,977	0	0	0	0	0	101,977	6.75
11019902 3 Excavation									
11019902 3 1 Dozer Excav., Pushed to Stkpile	82800.00 CY	139,692	0	0	0	0	0	139,692	1.69
11019902 3 2 Excavation and Haul	14500.00 CY	101,977	0	0	0	0	0	101,977	7.03
TOTAL Excavation	97300.00 CY	241,669	0	0	0	0	0	241,669	2.48
11019902 4 Embankment									
11019902 4 1 Dozer., Pushed to site	82800.00 CY	70,777	0	0	0	0	0	70,777	0.85
11019902 4 2 Compaction,	82800.00 CY	92,214	0	0	0	0	0	92,214	1.11
TOTAL Embankment	82800.00 CY	162,991	0	0	0	0	0	162,991	1.97
11019902 5 Soil Treatment									
11019902 5 1 Dozer Excav., Pushed to Stkpile	99720.00 CY	167,631	0	0	0	0	0	167,631	1.68
11019902 5 2 Excavation and Haul	99720.00 CY	585,001	0	0	0	0	0	585,001	5.87
11019902 5 3 Dozer., Pushed From Stkpile	99720.00 CY	83,815	0	0	0	0	0	83,815	0.84
11019902 5 4 Compaction,	199440.00 CY	217,959	0	0	0	0	0	217,959	1.09
TOTAL Soil Treatment	99720.00 CY	1,054,407	0	0	0	0	0	1,054,407	10.57
11019902 6 Drainage Material	97100.00 TN	1,704,741	0	0	0	0	0	1,704,741	17.56
11019902 7 Geotextile,	264000.00 SY	479,620	0	0	0	0	0	479,620	1.82
11019902 8 Erosion control Seeding	28.50 ACR	49,979	0	0	0	0	0	49,979	1753.63
TOTAL Site Work		4,150,925	0	0	0	0	0	4,150,925	
TOTAL Associated General Items		4,150,925	0	0	0	0	0	4,150,925	
TOTAL LEVEES		4,150,925	0	0	0	0	0	4,150,925	
TOTAL LEVEES AND FLOODWALLS		4,150,925	0	0	0	0	0	4,150,925	
TOTAL Mid-Valley Levee Restoration	1.00 EA	4,169,402	0	0	0	0	0	4,169,402	4169402

** PROJECT INDIRECT SUMMARY - (Unused) **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
02 RELOCATIONS								
0203 CEMETERIES,UTILITIES,& STRUCTURE								
020399 Associated General Items								
02039902 Site Work								
0203990201 Relocate 4'x6'x6'Concrete Distr.								
0203990201 1 Structural Excavation	28.00 CY	757	76	42	70	9	953	34.04
0203990201 2 Structural Backfill	28.00 CY	583	58	32	54	7	735	26.23
0203990201 3 Relocate Dist. Box	1.00 EA	1,298	130	71	120	16	1,635	1635.42
TOTAL Relocate 4'x6'x6'Concrete Distr.	1.00 EA	2,638	264	145	244	33	3,323	3323.16
0203990202 Relocate V Shape Irrig. Ditch								
0203990202 3 Excavation,	1222.00 CY	7,830	783	431	723	98	9,865	8.07
0203990202 4 Compaction,	1222.00 CY	4,199	420	231	388	52	5,290	4.33
TOTAL Relocate V Shape Irrig. Ditch	11000.00 LF	12,029	1,203	662	1,111	150	15,155	1.38
TOTAL Site Work		14,666	1,467	807	1,355	183	18,478	
TOTAL Associated General Items		14,666	1,467	807	1,355	183	18,478	
TOTAL CEMETERIES,UTILITIES,& STRUCTURE		14,666	1,467	807	1,355	183	18,478	
TOTAL RELOCATIONS		14,666	1,467	807	1,355	183	18,478	
11 LEVEES AND FLOODWALLS								
1101 LEVEES								
110199 Associated General Items								
11019902 Site Work								
11019902 1 Clearing and Grubbing								
11019902 1 1 Vegetation	28.50 ACR	5,439	544	299	503	68	6,853	240.45
11019902 1 3 Load, Haul & disposal 10mile	8493.00 CY	114,453	11,445	6,295	10,575	1,428	144,196	16.98
11019902 1 4 Cut Trees and Disposed	627.00 EA	102,655	10,265	5,646	9,485	1,281	129,332	206.27
11019902 1 5 Remove Stumps	627.00 EA	59,657	5,966	3,281	5,512	744	75,160	119.87
TOTAL Clearing and Grubbing	28.50 AC	282,203	28,220	15,521	26,076	3,520	355,540	12475.10

** PROJECT INDIRECT SUMMARY - (Unused) **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
11019902 2 Stripping	15110.00 CY	80,942	8,094	4,452	7,479	1,010	101,977	6.75
11019902 3 Excavation								
11019902 3 1 Dozer Excav., Pushed to Stkpile	82800.00 CY	110,878	11,088	6,098	10,245	1,383	139,692	1.69
11019902 3 2 Excavation and Haul	14500.00 CY	80,942	8,094	4,452	7,479	1,010	101,977	7.03
TOTAL Excavation	97300.00 CY	191,820	19,182	10,550	17,724	2,393	241,669	2.48
11019902 4 Embankment								
11019902 4 1 Dozer., Pushed to site	82800.00 CY	56,178	5,618	3,090	5,191	701	70,777	0.85
11019902 4 2 Compaction,	82800.00 CY	73,193	7,319	4,026	6,763	913	92,214	1.11
TOTAL Embankment	82800.00 CY	129,371	12,937	7,115	11,954	1,614	162,991	1.97
11019902 5 Soil Treatment								
11019902 5 1 Dozer Excav., Pushed to Stkpile	99720.00 CY	133,054	13,305	7,318	12,294	1,660	167,631	1.68
11019902 5 2 Excavation and Haul	99720.00 CY	464,333	46,433	25,538	42,904	5,792	585,001	5.87
11019902 5 3 Dozer., Pushed From Stkpile	99720.00 CY	66,527	6,653	3,659	6,147	830	83,815	0.84
11019902 5 4 Compaction,	199440.00 CY	173,001	17,300	9,515	15,985	2,158	217,959	1.09
TOTAL Soil Treatment	99720.00 CY	836,915	83,691	46,030	77,331	10,440	1,054,407	10.57
11019902 6 Drainage Material	97100.00 TN	1,353,104	135,310	74,421	125,027	16,879	1,704,741	17.56
11019902 7 Geotextile,	264000.00 SY	380,689	38,069	20,938	35,176	4,749	479,620	1.82
11019902 8 Erosion control Seeding	28.50 ACR	39,670	3,967	2,182	3,665	495	49,979	1753.63
TOTAL Site Work		3,294,714	329,471	181,209	304,432	41,098	4,150,925	
TOTAL Associated General Items		3,294,714	329,471	181,209	304,432	41,098	4,150,925	
TOTAL LEVEES		3,294,714	329,471	181,209	304,432	41,098	4,150,925	
TOTAL LEVEES AND FLOODWALLS		3,294,714	329,471	181,209	304,432	41,098	4,150,925	
TOTAL Mid-Valley Levee Restoration	1.00 EA	3,309,380	330,938	182,016	305,787	41,281	4,169,402	4169402

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
02 RELOCATIONS								
0203 CEMETERIES,UTILITIES,& STRUCTURE								
020399 Associated General Items								
02039902 Site Work								
0203990201 Relocate 4'x6'x6'Concrete Distr.								
0203990201 1 Structural Excavation	28.00	CY	14	483	274	0	757	27.02
0203990201 2 Structural Backfill	28.00	CY	8	305	278	0	583	20.82
0203990201 3 Relocate Dist. Box	1.00	EA	24	802	227	269	1,298	1298.08
TOTAL Relocate 4'x6'x6'Concrete Distr.	1.00	EA	46	1,589	779	269	2,638	2637.69
0203990202 Relocate V Shape Irrig. Ditch								
0203990202 3 Excavation,	1222.00	CY	84	3,087	4,743	0	7,830	6.41
0203990202 4 Compaction,	1222.00	CY	48	1,881	2,318	0	4,199	3.44
TOTAL Relocate V Shape Irrig. Ditch	11000.00	LF	132	4,967	7,061	0	12,029	1.09
TOTAL Site Work			178	6,557	7,840	269	14,666	
TOTAL Associated General Items			178	6,557	7,840	269	14,666	
TOTAL CEMETERIES,UTILITIES,& STRUCTURE			178	6,557	7,840	269	14,666	
TOTAL RELOCATIONS			178	6,557	7,840	269	14,666	
11 LEVEES AND FLOODWALLS								
1101 LEVEES								
110199 Associated General Items								
11019902 Site Work								
11019902 1 Clearing and Grubbing								
11019902 1 1 Vegetation	28.50	ACR	64	2,438	3,001	0	5,439	190.86
11019902 1 3 Load, Haul & disposal 10mile	8493.00	CY	936	33,933	34,764	45,756	114,453	13.48
11019902 1 4 Cut Trees and Disposed	627.00	EA	1,908	64,434	31,465	6,756	102,655	163.72
11019902 1 5 Remove Stumps	627.00	EA	1,060	39,611	16,668	3,378	59,657	95.15
TOTAL Clearing and Grubbing	28.50	AC	3,968	140,415	85,898	55,890	282,203	9901.87

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
11019902 2 Stripping	15110.00	CY	1,176	42,703	38,239	0	80,942	5.36
11019902 3 Excavation								
11019902 3 1 Dozer Excav., Pushed to Stkpile	82800.00	CY	1,500	54,602	56,276	0	110,878	1.34
11019902 3 2 Excavation and Haul	14500.00	CY	1,176	42,703	38,239	0	80,942	5.58
TOTAL Excavation	97300.00	CY	2,676	97,305	94,516	0	191,820	1.97
11019902 4 Embankment								
11019902 4 1 Dozer., Pushed to site	82800.00	CY	760	27,665	28,513	0	56,178	0.68
11019902 4 2 Compaction,	82800.00	CY	792	31,443	41,750	0	73,193	0.88
TOTAL Embankment	82800.00	CY	1,552	59,108	70,263	0	129,371	1.56
11019902 5 Soil Treatment								
11019902 5 1 Dozer Excav., Pushed to Stkpile	99720.00	CY	1,800	65,522	67,532	0	133,054	1.33
11019902 5 2 Excavation and Haul	99720.00	CY	6,664	242,324	222,010	0	464,333	4.66
11019902 5 3 Dozer., Pushed From Stkpile	99720.00	CY	900	32,761	33,766	0	66,527	0.67
11019902 5 4 Compaction,	199440.00	CY	1,872	74,320	98,681	0	173,001	0.87
TOTAL Soil Treatment	99720.00	CY	11,236	414,926	421,989	0	836,915	8.39
11019902 6 Drainage Material	97100.00	TN	9,720	338,470	282,258	732,377	1,353,104	13.94
11019902 7 Geotextile,	264000.00	SY	4,320	134,903	18,218	227,568	380,689	1.44
11019902 8 Erosion control Seeding	28.50	ACR	288	8,466	6,636	24,567	39,670	1391.91
TOTAL Site Work			34,936	1,236,295	1,018,017	1,040,402	3,294,714	
TOTAL Associated General Items			34,936	1,236,295	1,018,017	1,040,402	3,294,714	
TOTAL LEVEES			34,936	1,236,295	1,018,017	1,040,402	3,294,714	
TOTAL LEVEES AND FLOODWALLS			34,936	1,236,295	1,018,017	1,040,402	3,294,714	
TOTAL Mid-Valley Levee Restoration	1.00	EA	35,114	1,242,852	1,025,858	1,040,671	3,309,380	3309380
OVERHEAD							330,938	
SUBTOTAL							3,640,319	
HOME OFC							182,016	
SUBTOTAL							3,[illegible]22,334	
PROFIT							305,787	
SUBTOTAL							4,128,121	
BOND							41,281	

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
TOTAL INCL INDIRECTS							4,169,402	

Mid-Valley Levee Restoration
Area 2

Designed By: US Army Corps of Engineers
Estimated By: CESPK-ED-C

Prepared By: S. C. Fong

Preparation Date: 07/14/95
Effective Date of Pricing: 07/14/95

Sales Tax: 7.75%

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SUMMARY REPORTS — SUMMARY PAGE

No Detailed Estimate...

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* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - (Unused) **

	QUANTITY UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
02 RELOCATIONS									
0203 CEMETERIES,UTILITIES,& STRUCTURE									
020399 Associated General Items									
02039902 Site Work									
0203990202 Relocate V Shape Irrig. Ditch									
0203990202 3 Excavation,	78.00 CY	1,644	0	0	0	0	0	1,644	21.08
0203990202 4 Compaction,	78.00 CY	882	0	0	0	0	0	882	11.30
TOTAL Relocate V Shape Irrig. Ditch	700.00 LF	2,526	0	0	0	0	0	2,526	3.61
TOTAL Site Work		2,526	0	0	0	0	0	2,526	
TOTAL Associated General Items		2,526	0	0	0	0	0	2,526	
TOTAL CEMETERIES,UTILITIES,& STRUCTURE		2,526	0	0	0	0	0	2,526	
TOTAL RELOCATIONS		2,526	0	0	0	0	0	2,526	
11 LEVEES AND FLOODWALLS									
1101 LEVEES									
110199 Associated General Items									
11019902 Site Work									
11019902 1 Clearing and Grubbing									
11019902 1 1 Vegetation	24.40 ACR	5,140	0	0	0	0	0	5,140	210.64
11019902 1 3 Load, Haul & disposal 3mile	7271.00 CY	94,725	0	0	0	0	0	94,725	13.03
11019902 1 4 Cut Trees and Disposed	537.00 EA	109,873	0	0	0	0	0	109,873	204.61
11019902 1 5 Remove Stumps	537.00 EA	63,846	0	0	0	0	0	63,846	118.89
TOTAL Clearing and Grubbing	24.40 AC	273,584	0	0	0	0	0	273,584	11212.48
11019902 2 Stripping	5210.00 CY	26,560	0	0	0	0	0	26,560	5.10
11019902 3 Excavation									
11019902 3 1 Dozer Excav., Pushed to Stkpile	88120.00 CY	149,005	0	0	0	0	0	149,005	1.69
11019902 3 2 Excavation and Haul	34780.00 CY	169,986	0	0	0	0	0	169,986	4.89
TOTAL Excavation	122900.00 CY	318,991	0	0	0	0	0	318,991	2.60

** PROJECT OWNER SUMMARY - (Unused) **

	QUANTITY UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
11019902 4 Embankment									
11019902 4 1 Dozer., Pushed to site	88120.00 CY	74,503	0	0	0	0	0	74,503	0.85
11019902 4 2 Compaction,	88120.00 CY	97,802	0	0	0	0	0	97,802	1.11
TOTAL Embankment	88120.00 CY	172,305	0	0	0	0	0	172,305	1.96
11019902 5 Soil Treatment									
11019902 5 1 Dozer Excav., Pushed to Stkpile	159000.00 CY	266,347	0	0	0	0	0	266,347	1.68
11019902 5 2 Excavation and Haul	159000.00 CY	931,227	0	0	0	0	0	931,227	5.86
11019902 5 3 Dozer., Pushed From Stkpile	159000.00 CY	134,105	0	0	0	0	0	134,105	0.84
11019902 5 4 Compaction,	318000.00 CY	349,294	0	0	0	0	0	349,294	1.10
TOTAL Soil Treatment	159000.00 CY	1,680,972	0	0	0	0	0	1,680,972	10.57
11019902 6 Drainage Material	20550.00 TN	362,628	0	0	0	0	0	362,628	17.65
11019902 7 Geotextile,	80110.00 SY	145,589	0	0	0	0	0	145,589	1.82
11019902 8 Erosion control Seeding	24.40 ACR	43,412	0	0	0	0	0	43,412	1779.17
TOTAL Site Work		3,024,042	0	0	0	0	0	3,024,042	
TOTAL Associated General Items		3,024,042	0	0	0	0	0	3,024,042	
TOTAL LEVEES		3,024,042	0	0	0	0	0	3,024,042	
TOTAL LEVEES AND FLOODWALLS		3,024,042	0	0	0	0	0	3,024,042	
TOTAL Mid-Valley Levee Restoration	1.00 EA	3,026,568	0	0	0	0	0	3,026,568	3026568

** PROJECT INDIRECT SUMMARY - (Unused) **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
02 RELOCATIONS								
0203 CEMETERIES,UTILITIES,& STRUCTURE								
020399 Associated General Items								
02039902 Site Work								
0203990202 Relocate V Shape Irrig. Ditch								
0203990202 3 Excavation,	78.00 CY	1,305	130	72	121	16	1,644	21.08
0203990202 4 Compaction,	78.00 CY	700	70	38	65	9	882	11.30
TOTAL Relocate V Shape Irrig. Ditch	700.00 LF	2,005	200	110	185	25	2,526	3.61
TOTAL Site Work		2,005	200	110	185	25	2,526	
TOTAL Associated General Items		2,005	200	110	185	25	2,526	
TOTAL CEMETERIES,UTILITIES,& STRUCTURE		2,005	200	110	185	25	2,526	
TOTAL RELOCATIONS		2,005	200	110	185	25	2,526	
11 LEVEES AND FLOODWALLS								
1101 LEVEES								
110199 Associated General Items								
11019902 Site Work								
11019902 1 Clearing and Grubbing								
11019902 1 1 Vegetation	24.40 ACR	4,080	408	224	377	51	5,140	210.64
11019902 1 3 Load, Haul & disposal 3mile	7271.00 CY	75,186	7,519	4,135	6,947	938	94,725	13.03
11019902 1 4 Cut Trees and Disposed	537.00 EA	87,209	8,721	4,797	8,058	1,088	109,873	204.61
11019902 1 5 Remove Stumps	537.00 EA	50,677	5,068	2,787	4,683	632	63,846	118.89
TOTAL Clearing and Grubbing	24.40 AC	217,152	21,715	11,943	20,065	2,709	273,584	11212.48
11019902 2 Stripping	5210.00 CY	21,082	2,108	1,159	1,948	263	26,560	5.10
11019902 3 Excavation								
11019902 3 1 Dozer Excav., Pushed to Stkpile	88120.00 CY	118,270	11,827	6,505	10,928	1,475	149,005	1.69
11019902 3 2 Excavation and Haul	34780.00 CY	134,923	13,492	7,421	12,467	1,683	169,986	4.89
TOTAL Excavation	122900.00 CY	253,193	25,319	13,926	23,395	3,158	318,991	2.60

** PROJECT INDIRECT SUMMARY - (Unused) **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
11019902 4 Embankment								
11019902 4 1 Dozer., Pushed to site	88120.00 CY	59,135	5,913	3,252	5,464	738	74,503	0.85
11019902 4 2 Compaction,	88120.00 CY	77,629	7,763	4,270	7,173	968	97,802	1.11
TOTAL Embankment	88120.00 CY	136,764	13,676	7,522	12,637	1,706	172,305	1.96
11019902 5 Soil Treatment								
11019902 5 1 Dozer Excav., Pushed to Stkpile	159000.00 CY	211,407	21,141	11,627	19,534	2,637	266,347	1.68
11019902 5 2 Excavation and Haul	159000.00 CY	739,143	73,914	40,653	68,297	9,220	931,227	5.86
11019902 5 3 Dozer., Pushed From Stkpile	159000.00 CY	106,443	10,644	5,854	9,835	1,328	134,105	0.84
11019902 5 4 Compaction,	318000.00 CY	277,245	27,725	15,248	25,617	3,458	349,294	1.10
TOTAL Soil Treatment	159000.00 CY	1,334,238	133,424	73,383	123,284	16,643	1,680,972	10.57
11019902 6 Drainage Material	20550.00 TN	287,829	28,783	15,831	26,595	3,590	362,628	17.65
11019902 7 Geotextile,	80110.00 SY	115,558	11,556	6,356	10,678	1,441	145,589	1.82
11019902 8 Erosion control Seeding	24.40 ACR	34,457	3,446	1,895	3,184	430	43,412	1779.17
TOTAL Site Work		2,400,273	240,027	132,015	221,785	29,941	3,024,042	
TOTAL Associated General Items		2,400,273	240,027	132,015	221,785	29,941	3,024,042	
TOTAL LEVEES		2,400,273	240,027	132,015	221,785	29,941	3,024,042	
TOTAL LEVEES AND FLOODWALLS		2,400,273	240,027	132,015	221,785	29,941	3,024,042	
TOTAL Mid-Valley Levee Restoration	1.00 EA	2,402,278	240,228	132,125	221,970	29,966	3,026,568	3026568

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
02 RELOCATIONS								
0203 CEMETERIES,UTILITIES,& STRUCTURE								
020399 Associated General Items								
02039902 Site Work								
0203990202 Relocate V Shape Irrig. Ditch								
0203990202 3 Excavation,	78.00	CY	14	514	791	0	1,305	16.73
0203990202 4 Compaction,	78.00	CY	8	313	386	0	700	8.97
TOTAL Relocate V Shape Irrig. Ditch	700.00	LF	22	828	1,177	0	2,005	2.86
TOTAL Site Work			22	828	1,177	0	2,005	
TOTAL Associated General Items			22	828	1,177	0	2,005	
TOTAL CEMETERIES,UTILITIES,& STRUCTURE			22	828	1,177	0	2,005	
TOTAL RELOCATIONS			22	828	1,177	0	2,005	
11 LEVEES AND FLOODWALLS								
1101 LEVEES								
110199 Associated General Items								
11019902 Site Work								
11019902 1 Clearing and Grubbing								
11019902 1 1 Vegetation	24.40	ACR	48	1,828	2,251	0	4,080	167.19
11019902 1 3 Load, Haul & disposal 3mile	7271.00	CY	480	17,417	18,597	39,173	75,186	10.34
11019902 1 4 Cut Trees and Disposed	537.00	EA	1,620	54,708	26,715	5,786	87,209	162.40
11019902 1 5 Remove Stumps	537.00	EA	900	33,632	14,152	2,893	50,677	94.37
TOTAL Clearing and Grubbing	24.40	AC	3,048	107,585	61,716	47,852	217,152	8899.68
11019902 2 Stripping	5210.00	CY	300	10,920	10,162	0	21,082	4.05
11019902 3 Excavation								
11019902 3 1 Dozer Excav., Pushed to Stkpile	88120.00	CY	1,600	58,242	60,028	0	118,270	1.34
11019902 3 2 Excavation and Haul	34780.00	CY	1,920	69,886	65,037	0	134,923	3.88
TOTAL Excavation	122900.00	CY	3,520	128,127	125,066	0	253,193	2.06

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
11019902 4 Embankment								
11019902 4 1 Dozer., Pushed to site	88120.00	CY	800	29,121	30,014	0	59,135	0.67
11019902 4 2 Compaction,	88120.00	CY	840	33,349	44,280	0	77,629	0.88
TOTAL Embankment	88120.00	CY	1,640	62,469	74,294	0	136,764	1.55
11019902 5 Soil Treatment								
11019902 5 1 Dozer Excav., Pushed to Stkpile	159000.00	CY	2,860	104,107	107,300	0	211,407	1.33
11019902 5 2 Excavation and Haul	159000.00	CY	10,608	385,739	353,403	0	739,143	4.65
11019902 5 3 Dozer., Pushed From Stkpile	159000.00	CY	1,440	52,418	54,025	0	106,443	0.67
11019902 5 4 Compaction,	318000.00	CY	3,000	119,102	158,143	0	277,245	0.87
TOTAL Soil Treatment	159000.00	CY	17,908	661,366	672,872	0	1,334,238	8.39
11019902 6 Drainage Material	20550.00	TN	2,080	72,430	60,401	154,998	287,829	14.01
11019902 7 Geotextile,	80110.00	SY	1,312	40,970	5,533	69,055	115,558	1.44
11019902 8 Erosion control Seeding	24.40	ACR	256	7,525	5,899	21,033	34,457	1412.18
TOTAL Site Work			30,064	1,091,393	1,015,943	292,938	2,400,273	
TOTAL Associated General Items			30,064	1,091,393	1,015,943	292,938	2,400,273	
TOTAL LEVEES			30,064	1,091,393	1,015,943	292,938	2,400,273	
TOTAL LEVEES AND FLOODWALLS			30,064	1,091,393	1,015,943	292,938	2,400,273	
TOTAL Mid-Valley Levee Restoration	1.00	EA	30,086	1,092,221	1,017,119	292,938	2,402,278	2402278
OVERHEAD							240,228	
SUBTOTAL							2,642,506	
HOME OFC							132,125	
SUBTOTAL							2,774,631	
PROFIT							221,970	
SUBTOTAL							2,996,602	
BOND							29,966	
TOTAL INCL INDIRECTS							3,026,568	

Mid-Valley Levee Restoration
Area 3

Designed By: US Army Corps of Engineers
Estimated By: CESPK-ED-C

Prepared By: S. C. Fong

Preparation Date: 07/14/95
Effective Date of Pricing: 07/14/95

Sales Tax: 7.75%

SUMMARY REPORTS — SUMMARY PAGE

No Detailed Estimate...

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - (Unused) **

	QUANTITY UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
11 LEVEES AND FLOODWALLS									
1101 LEVEES									
110199 Associated General Items									
11019902 Site Work									
11019902 1 Clearing and Grubbing									
11019902 1 1 Vegetation	83.60 ACR	17,132	0	0	0	0	0	17,132	204.93
11019902 1 3 Load, Haul & disposal 5mile	24913.00 CY	333,652	0	0	0	0	0	333,652	13.39
11019902 1 4 Cut Trees and Disposed	1839.00 EA	376,027	0	0	0	0	0	376,027	204.47
11019902 1 5 Remove Stumps	1839.00 EA	218,505	0	0	0	0	0	218,505	118.82
TOTAL Clearing and Grubbing	83.60 AC	945,316	0	0	0	0	0	945,316	11307.61
11019902 2 Stripping	9970.00 CY	50,767	0	0	0	0	0	50,767	5.09
11019902 3 Excavation									
11019902 3 1 Dozer Excav., Pushed to Stkpile	127140.00 CY	214,195	0	0	0	0	0	214,195	1.68
11019902 3 2 Excavation and Haul	458690.00 CY	2,329,624	0	0	0	0	0	2,329,624	5.08
TOTAL Excavation	585830.00 CY	2,543,818	0	0	0	0	0	2,543,818	4.34
11019902 4 Embankment									
11019902 4 1 Dozer., Pushed From Stkpile	127140.00 CY	108,029	0	0	0	0	0	108,029	0.85
11019902 4 2 Compaction,	127140.00 CY	139,718	0	0	0	0	0	139,718	1.10
TOTAL Embankment	127140.00 CY	247,746	0	0	0	0	0	247,746	1.95
11019902 5 Soil Treatment									
11019902 5 1 Dozer Excav., Pushed to Stkpile	606600.00 CY	1,015,097	0	0	0	0	0	1,015,097	1.67
11019902 5 2 Excavation and Haul	606600.00 CY	3,539,856	0	0	0	0	0	3,539,856	5.84
11019902 5 3 Dozer., Pushed From Stkpile	606600.00 CY	508,480	0	0	0	0	0	508,480	0.84
11019902 5 4 Compaction,	1213200 CY	1,324,523	0	0	0	0	0	1,324,523	1.09
TOTAL Soil Treatment	606600.00 CY	6,387,956	0	0	0	0	0	6,387,956	10.53
11019902 6 Drainage Material	18170.00 TN	320,702	0	0	0	0	0	320,702	17.65
11019902 7 Geotextile,	232000.00 SY	422,004	0	0	0	0	0	422,004	1.82
11019902 8 Erosion control Seeding	83.60 ACR	146,815	0	0	0	0	0	146,815	1756.16
TOTAL Site Work		11,065,126	0	0	0	0	0	11,065,126	

** PROJECT OWNER SUMMARY - (Unused) **

	QUANTITY UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
TOTAL Associated General Items		11,065,126	0	0	0	0	0	11,065,126	
TOTAL LEVEES		11,065,126	0	0	0	0	0	11,065,126	
TOTAL LEVEES AND FLOODWALLS		11,065,126	0	0	0	0	0	11,065,126	
TOTAL Mid-Valley Levee Restoration	1.00 EA	11,065,126	0	0	0	0	0	11,065,126	11065126

** PROJECT INDIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
11 LEVEES AND FLOODWALLS									
1101 LEVEES									
110199 Associated General Items									
11019902 Site Work									
11019902 1 Clearing and Grubbing									
11019902 1 1 Vegetation	83.60	ACR	13,598	1,360	748	1,256	170	17,132	204.93
11019902 1 3 Load, Haul & disposal 5mile	24913.00	CY	264,830	26,483	14,566	24,470	3,303	333,652	13.39
11019902 1 4 Cut Trees and Disposed	1839.00	EA	298,464	29,846	16,416	27,578	3,723	376,027	204.47
11019902 1 5 Remove Stumps	1839.00	EA	173,434	17,343	9,539	16,025	2,163	218,505	118.82
TOTAL Clearing and Grubbing	83.60	AC	750,326	75,033	41,268	69,330	9,360	945,316	11307.61
11019902 2 Stripping	9970.00	CY	40,295	4,029	2,216	3,723	503	50,767	5.09
11019902 3 Excavation									
11019902 3 1 Dozer Excav., Pushed to Stkpile	127140.00	CY	170,013	17,001	9,351	15,709	2,121	214,195	1.68
11019902 3 2 Excavation and Haul	458690.00	CY	1,849,093	184,909	101,700	170,856	23,066	2,329,624	5.08
TOTAL Excavation	585830.00	CY	2,019,105	201,911	111,051	186,565	25,186	2,543,818	4.34
11019902 4 Embankment									
11019902 4 1 Dozer., Pushed From Stkpile	127140.00	CY	85,746	8,575	4,716	7,923	1,070	108,029	0.85
11019902 4 2 Compaction,	127140.00	CY	110,898	11,090	6,099	10,247	1,383	139,718	1.10
TOTAL Embankment	127140.00	CY	196,644	19,664	10,815	18,170	2,453	247,746	1.95
11019902 5 Soil Treatment									
11019902 5 1 Dozer Excav., Pushed to Stkpile	606600.00	CY	805,713	80,571	44,314	74,448	10,050	1,015,097	1.67
11019902 5 2 Excavation and Haul	606600.00	CY	2,809,690	280,969	154,533	259,615	35,048	3,539,856	5.84
11019902 5 3 Dozer., Pushed From Stkpile	606600.00	CY	403,596	40,360	22,198	37,292	5,034	508,480	0.84
11019902 5 4 Compaction,	1213200	CY	1,051,314	105,131	57,822	97,141	13,114	1,324,523	1.09
TOTAL Soil Treatment	606600.00	CY	5,070,314	507,031	278,867	468,497	63,247	6,387,956	10.53
11019902 6 Drainage Material	18170.00	TN	254,551	25,455	14,000	23,521	3,175	320,702	17.65
11019902 7 Geotextile,	232000.00	SY	334,958	33,496	18,423	30,950	4,178	422,004	1.82
11019902 8 Erosion control Seeding	83.60	ACR	116,532	11,653	6,409	10,768	1,454	146,815	1756.16
TOTAL Site Work			8,782,724	878,272	483,050	811,524	109,556	11,065,126	

** PROJECT INDIRECT SUMMARY - (Unused) **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
TOTAL Associated General Items		8,782,724	878,272	483,050	811,524	109,556	11,065,126	
TOTAL LEVEES		8,782,724	878,272	483,050	811,524	109,556	11,065,126	
TOTAL LEVEES AND FLOODWALLS		8,782,724	878,272	483,050	811,524	109,556	11,065,126	
TOTAL Mid-Valley Levee Restoration	1.00 EA	8,782,724	878,272	483,050	811,524	109,556	11,065,126	11065126

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
11 LEVEES AND FLOODWALLS								
1101 LEVEES								
110199 Associated General Items								
11019902 Site Work								
11019902 1 Clearing and Grubbing								
11019902 1 1 Vegetation	83.60	ACR	160	6,095	7,504	0	13,598	162.66
11019902 1 3 Load, Haul & disposal 5mile	24913.00	CY	1,768	64,111	66,499	134,219	264,830	10.63
11019902 1 4 Cut Trees and Disposed	1839.00	EA	5,544	187,223	91,426	19,815	298,464	162.30
11019902 1 5 Remove Stumps	1839.00	EA	3,080	115,095	48,431	9,908	173,434	94.31
TOTAL Clearing and Grubbing	83.60	AC	10,552	372,525	213,860	163,942	750,326	8975.19
11019902 2 Stripping	9970.00	CY	576	20,955	19,340	0	40,295	4.04
11019902 3 Excavation								
11019902 3 1 Dozer Excav., Pushed to Stkpile	127140.00	CY	2,300	83,722	86,290	0	170,013	1.34
11019902 3 2 Excavation and Haul	458690.00	CY	26,432	961,592	887,501	0	1,849,093	4.03
TOTAL Excavation	585830.00	CY	28,732	1,045,314	973,791	0	2,019,105	3.45
11019902 4 Embankment								
11019902 4 1 Dozer., Pushed From Stkpile	127140.00	CY	1,160	42,225	43,520	0	85,746	0.67
11019902 4 2 Compaction,	127140.00	CY	1,200	47,641	63,257	0	110,898	0.87
TOTAL Embankment	127140.00	CY	2,360	89,866	106,778	0	196,644	1.55
11019902 5 Soil Treatment								
11019902 5 1 Dozer Excav., Pushed to Stkpile	606600.00	CY	10,900	396,772	408,942	0	805,713	1.33
11019902 5 2 Excavation and Haul	606600.00	CY	40,324	1,466,304	1,343,386	0	2,809,690	4.63
11019902 5 3 Dozer., Pushed From Stkpile	606600.00	CY	5,460	198,750	204,846	0	403,596	0.67
11019902 5 4 Compaction,	1213200	CY	11,376	451,635	599,679	0	1,051,314	0.87
TOTAL Soil Treatment	606600.00	CY	68,060	2,513,461	2,556,853	0	5,070,314	8.36
11019902 6 Drainage Material	18170.00	TN	1,840	64,072	53,431	137,047	254,551	14.01
11019902 7 Geotextile,	232000.00	SY	3,808	118,914	16,059	199,984	334,958	1.44
11019902 8 Erosion control Seeding	83.60	ACR	848	24,928	19,541	72,063	116,532	1393.92
TOTAL Site Work			116,776	4,250,035	3,959,653	573,036	8,782,724	

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
TOTAL Associated General Items		116,776	4,250,035	3,959,653	573,036	8,782,724	
TOTAL LEVEES		116,776	4,250,035	3,959,653	573,036	8,782,724	
TOTAL LEVEES AND FLOODWALLS		116,776	4,250,035	3,959,653	573,036	8,782,724	
TOTAL Mid-Valley Levee Restoration	1.00 EA	116,776	4,250,035	3,959,653	573,036	8,782,724	8782724
OVERHEAD						878,272	
SUBTOTAL						9,660,996	
HOME OFC						483,050	
SUBTOTAL						10,144,046	
PROFIT						811,524	
SUBTOTAL						10,955,570	
BOND						109,556	
TOTAL INCL INDIRECTS						11,065,126	

Mid-Valley Levee Restoration
Area 4

Designed By: US Army Corps of Engineers
Estimated By: CESPK-ED-C

Prepared By: S. C. Fong

Preparation Date: 07/14/95
Effective Date of Pricing: 07/14/95

Sales Tax: 7.75%

SUMMARY REPORTS — SUMMARY PAGE

No Detailed Estimate...

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - (Unused) **

	QUANTITY	UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
11 LEVEES AND FLOODWALLS										
1101 LEVEES										
110199 Associated General Items										
11019902 Site Work										
11019902 1 Clearing and Grubbing										
11019902 1 1 Vegetation	3.80	ACR	1,713	0	0	0	0	0	1,713	450.85
11019902 1 3 Load, Haul & disposal 20mile	1132.00	CY	25,111	0	0	0	0	0	25,111	22.18
11019902 1 4 Cut Trees and Disposed	84.00	EA	17,098	0	0	0	0	0	17,098	203.54
11019902 1 5 Remove Stumps	84.00	EA	9,935	0	0	0	0	0	9,935	118.27
TOTAL Clearing and Grubbing	3.80	AC	53,857	0	0	0	0	0	53,857	14172.92
11019902 2 Stripping	1700.00	CY	23,824	0	0	0	0	0	23,824	14.01
11019902 3 Excavation										
11019902 3 1 Dozer Excav., Pushed to Stkpile	3410.00	CY	7,450	0	0	0	0	0	7,450	2.18
TOTAL Excavation	3410.00	CY	7,450	0	0	0	0	0	7,450	2.18
11019902 4 Embankment										
11019902 4 1 Dozer., Pushed to site	3410.00	CY	3,725	0	0	0	0	0	3,725	1.09
11019902 4 2 Compaction,	3410.00	CY	5,589	0	0	0	0	0	5,589	1.64
11019902 4 3 Excavation and Haul	30190.00	CY	139,787	0	0	0	0	0	139,787	4.63
11019902 4 4 Compaction,	30190.00	CY	42,318	0	0	0	0	0	42,318	1.40
TOTAL Embankment	23600.00	CY	191,419	0	0	0	0	0	191,419	8.11
11019902 6 Drainage Material	8650.00	TN	152,999	0	0	0	0	0	152,999	17.69
11019902 7 Geotextile,	33800.00	SY	62,429	0	0	0	0	0	62,429	1.85
11019902 8 Erosion control Seeding	3.80	ACR	7,298	0	0	0	0	0	7,298	1920.54
1101990210 Slurry Cutoff Wall, 2'wide	18000.00	SF	120,586	0	0	0	0	0	120,586	6.70
TOTAL Site Work			619,863	0	0	0	0	0	619,863	
TOTAL Associated General Items			619,863	0	0	0	0	0	619,863	
TOTAL LEVEES			619,863	0	0	0	0	0	619,863	
TOTAL LEVEES AND FLOODWALLS			619,863	0	0	0	0	0	619,863	
TOTAL Mid-Valley Levee Restoration	1.00	EA	619,863	0	0	0	0	0	619,863	619862.97

** PROJECT INDIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
11 LEVEES AND FLOODWALLS									
1101 LEVEES									
110199 Associated General Items									
11019902 Site Work									
11019902 1 Clearing and Grubbing									
11019902 1 1 Vegetation	3.80	ACR	1,360	136	75	126	17	1,713	450.85
11019902 1 3 Load, Haul & disposal 20mile	1132.00	CY	19,932	1,993	1,096	1,842	249	25,111	22.18
11019902 1 4 Cut Trees and Disposed	84.00	EA	13,571	1,357	746	1,254	169	17,098	203.54
11019902 1 5 Remove Stumps	84.00	EA	7,886	789	434	729	98	9,935	118.27
TOTAL Clearing and Grubbing	3.80	AC	42,748	4,275	2,351	3,950	533	53,857	14172.92
11019902 2 Stripping	1700.00	CY	18,910	1,891	1,040	1,747	236	23,824	14.01
11019902 3 Excavation									
11019902 3 1 Dozer Excav., Pushed to Stkpile	3410.00	CY	5,913	591	325	546	74	7,450	2.18
TOTAL Excavation	3410.00	CY	5,913	591	325	546	74	7,450	2.18
11019902 4 Embankment									
11019902 4 1 Dozer., Pushed to site	3410.00	CY	2,957	296	163	273	37	3,725	1.09
11019902 4 2 Compaction,	3410.00	CY	4,436	444	244	410	55	5,589	1.64
11019902 4 3 Excavation and Haul	30190.00	CY	110,953	11,095	6,102	10,252	1,384	139,787	4.63
11019902 4 4 Compaction,	30190.00	CY	33,589	3,359	1,847	3,104	419	42,318	1.40
TOTAL Embankment	23600.00	CY	151,935	15,193	8,356	14,039	1,895	191,419	8.11
11019902 6 Drainage Material	8650.00	TN	121,440	12,144	6,679	11,221	1,515	152,999	17.69
11019902 7 Geotextile,	33800.00	SY	49,552	4,955	2,725	4,579	618	62,429	1.85
11019902 8 Erosion control Seeding	3.80	ACR	5,793	579	319	535	72	7,298	1920.54
1101990210 Slurry Cutoff Wall, 2'wide	18000.00	SF	95,713	9,571	5,264	8,844	1,194	120,586	6.70
TOTAL Site Work			492,004	49,200	27,060	45,461	6,137	619,863	
TOTAL Associated General Items			492,004	49,200	27,060	45,461	6,137	619,863	
TOTAL LEVEES			492,004	49,200	27,060	45,461	6,137	619,863	
TOTAL LEVEES AND FLOODWALLS			492,004	49,200	27,060	45,461	6,137	619,863	
TOTAL Mid-Valley Levee Restoration	1.00	EA	492,004	49,200	27,060	45,461	6,137	619,863	619862.97

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
11 LEVEES AND FLOODWALLS								
1101 LEVEES								
110199 Associated General Items								
11019902 Site Work								
11019902 1 Clearing and Grubbing								
11019902 1 1 Vegetation	3.80	ACR	16	609	750	0	1,360	357.85
11019902 1 3 Load, Haul & disposal 20mile	1132.00	CY	176	6,398	7,435	6,099	19,932	17.61
11019902 1 4 Cut Trees and Disposed	84.00	EA	252	8,510	4,156	905	13,571	161.56
11019902 1 5 Remove Stumps	84.00	EA	140	5,232	2,201	453	7,886	93.88
TOTAL Clearing and Grubbing	3.80	AC	584	20,749	14,542	7,456	42,748	11249.48
11019902 2 Stripping	1700.00	CY	276	10,017	8,893	0	18,910	11.12
11019902 3 Excavation								
11019902 3 1 Dozer Excav., Pushed to Stkpile	3410.00	CY	80	2,912	3,001	0	5,913	1.73
TOTAL Excavation	3410.00	CY	80	2,912	3,001	0	5,913	1.73
11019902 4 Embankment								
11019902 4 1 Dozer., Pushed to site	3410.00	CY	40	1,456	1,501	0	2,957	0.87
11019902 4 2 Compaction,	3410.00	CY	48	1,906	2,530	0	4,436	1.30
11019902 4 3 Excavation and Haul	30190.00	CY	1,680	60,629	50,324	0	110,953	3.68
11019902 4 4 Compaction,	30190.00	CY	384	15,044	18,545	0	33,589	1.11
TOTAL Embankment	23600.00	CY	2,152	79,035	72,900	0	151,935	6.44
11019902 6 Drainage Material	8650.00	TN	880	30,643	25,554	65,243	121,440	14.04
11019902 7 Geotextile,	33800.00	SY	576	17,987	2,429	29,136	49,552	1.47
11019902 8 Erosion control Seeding	3.80	ACR	48	1,411	1,106	3,276	5,793	1524.39
1101990210 Slurry Cutoff Wall, 2'wide	18000.00	SF	1,330	45,906	36,218	13,588	95,713	5.32
TOTAL Site Work			5,926	208,661	164,644	118,698	492,004	
TOTAL Associated General Items			5,926	208,661	164,644	118,698	492,004	
TOTAL LEVEES			5,926	208,661	164,644	118,698	492,004	
TOTAL LEVEES AND FLOODWALLS			5,926	208,661	164,644	118,698	492,004	
TOTAL Mid-Valley Levee Restoration	1.00	EA	5,926	208,661	164,644	118,698	492,004	492003.94

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
OVERHEAD							49,200	
SUBTOTAL							541,204	
HOME OFC							27,060	
SUBTOTAL							568,265	
PROFIT							45,461	
SUBTOTAL							613,726	
BOND							6,137	
TOTAL INCL INDIRECTS							619,863	

Mid-Valley Levee Restoration
Mitigation Contract

Designed By: US Army Corps of Engineers
Estimated By: CESPK-ED-C

Prepared By: S. C. Fong

Preparation Date: 09/10/95
Effective Date of Pricing: 09/10/95

Sales Tax: 7.75%

SUMMARY REPORTS SUMMARY PAGE

No Detailed Estimate...

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - (Unused) **

		QUANTITY	UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
06	FISH AND WILDLIFE										
0603	WILDLIFE FACILITIES AND SANCT.										
060373	Habitat and Feeding Facilities										
06037302	Site										
06037302 1	Mitigation										
06037302 1 1	Detailed Plan	1.00	JOB	14,498	0	0	0	0	0	14,498	14498.10
06037302 1 2	Access Road Layout & Construct.	3520.00	TON	51,739	0	0	0	0	0	51,739	14.70
06037302 1 3	Soil Testing	1.00	JOB	1,933	0	0	0	0	0	1,933	1933.08
06037302 1 4	Rough Grading	968000.00	SY	101,924	0	0	0	0	0	101,924	0.11
06037302 1 5	Erosion control Seeding	200.00	ACR	292,588	0	0	0	0	0	292,588	1462.94
06037302 1 6	Electrical	1.00	JOB	4,833	0	0	0	0	0	4,833	4832.70
06037302 1 7	Auto Irr. System	29268.00	EA	283,966	0	0	0	0	0	283,966	9.70
06037302 1 8	Fencing, Welded Wire Fence	5280.00	LF	30,521	0	0	0	0	0	30,521	5.78
06037302 1 9	Signs	15.00	EA	4,087	0	0	0	0	0	4,087	272.47
06037302 110	Elderberry Transplanting Clumps	12.00	EA	29,106	0	0	0	0	0	29,106	2425.49
06037302 111	Plant Pick-up	29268.00	EA	8,891	0	0	0	0	0	8,891	0.30
06037302 112	Planting Layout, Terrestrial	29268.00	EA	30,823	0	0	0	0	0	30,823	1.05
06037302 113	Container Plant Installation	23286.00	EA	343,622	0	0	0	0	0	343,622	14.76
06037302 114	Direct Seed Installation	2000.00	EA	20,284	0	0	0	0	0	20,284	10.14
06037302 115	Pole Cutting Installation	4000.00	EA	45,642	0	0	0	0	0	45,642	11.41
06037302 116	Irrigation Operation-3 Yr	90.00	EA	133,963	0	0	0	0	0	133,963	1488.47
06037302 117	Weeding 3yr	36.00	EA	334,314	0	0	0	0	0	334,314	9286.49
06037302 118	Access Road Maintenance	880.00	TON	13,964	0	0	0	0	0	13,964	15.87
06037302 119	As-Built and Reports	1.00	JOB	14,498	0	0	0	0	0	14,498	14498.10
06037302 120	Reports	3.00	EA	28,996	0	0	0	0	0	28,996	9665.40
06037302 121	Cleanup	29268.00	EA	28,289	0	0	0	0	0	28,289	0.97
	TOTAL Mitigation	75.00	ACR	1,818,481	0	0	0	0	0	1,818,481	24246.41
	TOTAL Site			1,818,481	0	0	0	0	0	1,818,481	
	TOTAL Habitat and Feeding Facilities			1,818,481	0	0	0	0	0	1,818,481	
	TOTAL WILDLIFE FACILITIES AND SANCT.			1,818,481	0	0	0	0	0	1,818,481	
	TOTAL FISH AND WILDLIFE			1,818,481	0	0	0	0	0	1,818,481	
	TOTAL Mid-Valley Levee Restoration	1.00	EA	1,818,481	0	0	0	0	0	1,818,481	1818481

** PROJECT INDIRECT SUMMARY - (Unused) **

	QUANTITY UOM	DIRECT	OVERHEAD	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT COST
06 FISH AND WILDLIFE								
0603 WILDLIFE FACILITIES AND SANCT.								
060373 Habitat and Feeding Facilities								
06037302 Site								
06037302 1 Mitigation								
06037302 1 1 Detailed Plan	1.00 JOB	12,000	600	630	1,125	144	14,498	14498.10
06037302 1 2 Access Road Layout & Construct.	3520.00 TON	42,824	2,141	2,248	4,013	512	51,739	14.70
06037302 1 3 Soil Testing	1.00 JOB	1,600	80	84	150	19	1,933	1933.08
06037302 1 4 Rough Grading	968000.00 SY	84,362	4,218	4,429	7,906	1,009	101,924	0.11
06037302 1 5 Erosion control Seeding	200.00 ACR	242,174	12,109	12,714	22,695	2,897	292,588	1462.94
06037302 1 6 Electrical	1.00 JOB	4,000	200	210	375	48	4,833	4832.70
06037302 1 7 Auto Irr. System	29268.00 EA	235,037	11,752	12,339	22,026	2,812	283,966	9.70
06037302 1 8 Fencing, Welded Wire Fence	5280.00 LF	25,262	1,263	1,326	2,367	302	30,521	5.78
06037302 1 9 Signs	15.00 EA	3,383	169	178	317	40	4,087	272.47
06037302 110 Elderberry Transplanting Clumps	12.00 EA	24,091	1,205	1,265	2,258	288	29,106	2425.49
06037302 111 Plant Pick-up	29268.00 EA	7,359	368	386	690	88	8,891	0.30
06037302 112 Planting Layout, Terrestrial	29268.00 EA	25,512	1,276	1,339	2,391	305	30,823	1.05
06037302 113 Container Plant Installation	23286.00 EA	284,414	14,221	14,932	26,653	3,402	343,622	14.76
06037302 114 Direct Seed Installation	2000.00 EA	16,789	839	881	1,573	201	20,284	10.14
06037302 115 Pole Cutting Installation	4000.00 EA	37,778	1,889	1,983	3,540	452	45,642	11.41
06037302 116 Irrigation Operation-3 Yr	90.00 EA	110,880	5,544	5,821	10,391	1,326	133,963	1488.47
06037302 117 Weeding 3yr	36.00 EA	276,710	13,835	14,527	25,931	3,310	334,314	9286.49
06037302 118 Access Road Maintenance	880.00 TON	11,558	578	607	1,083	138	13,964	15.87
06037302 119 As-Built and Reports	1.00 JOB	12,000	600	630	1,125	144	14,498	14498.10
06037302 120 Reports	3.00 EA	24,000	1,200	1,260	2,249	287	28,996	9665.40
06037302 121 Cleanup	29268.00 EA	23,414	1,171	1,229	2,194	280	28,289	0.97
TOTAL Mitigation	75.00 ACR	1,505,147	75,257	79,020	141,051	18,005	1,818,481	24246.41
TOTAL Site		1,505,147	75,257	79,020	141,051	18,005	1,818,481	
TOTAL Habitat and Feeding Facilities		1,505,147	75,257	79,020	141,051	18,005	1,818,481	
TOTAL WILDLIFE FACILITIES AND SANCT.		1,505,147	75,257	79,020	141,051	18,005	1,818,481	
TOTAL FISH AND WILDLIFE		1,505,147	75,257	79,020	141,051	18,005	1,818,481	
TOTAL Mid-Valley Levee Restoration	1.00 EA	1,505,147	75,257	79,020	141,051	18,005	1,818,481	1818481

** PROJECT DIRECT SUMMARY - (Unused) **

		QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
06	FISH AND WILDLIFE								
0603	WILDLIFE FACILITIES AND SANCT.								
060373	Habitat and Feeding Facilities								
06037302	Site								
06037302 1	Mitigation								
06037302 1 1	Detailed Plan	1.00	JOB	0	0	0	0	12,000	12000.00
06037302 1 2	Access Road Layout & Construct.	3520.00	TON	336	12,256	11,604	18,964	42,824	12.17
06037302 1 3	Soil Testing	1.00	JOB	0	0	0	0	1,600	1600.00
06037302 1 4	Rough Grading	968000.00	SY	1,008	39,181	45,181	0	84,362	0.09
06037302 1 5	Erosion control Seeding	200.00	ACR	2,000	58,793	43,306	140,075	242,174	1210.87
06037302 1 6	Electrical	1.00	JOB	0	0	0	0	4,000	4000.00
06037302 1 7	Auto Irr. System	29268.00	EA	4,884	163,633	14,639	56,765	235,037	8.03
06037302 1 8	Fencing, Welded Wire Fence	5280.00	LF	48	1,446	377	23,440	25,262	4.78
06037302 1 9	Signs	15.00	EA	24	851	108	2,424	3,383	225.52
06037302 110	Elderberry Transplanting Clumps	12.00	EA	660	22,113	1,978	0	24,091	2007.57
06037302 111	Plant Pick-up	29268.00	EA	180	6,031	1,329	0	7,359	0.25
06037302 112	Planting Layout, Terrestrial	29268.00	EA	588	19,700	4,235	1,577	25,512	0.87
06037302 113	Container Plant Installation	23286.00	EA	3,888	130,263	28,698	125,453	284,414	12.21
06037302 114	Direct Seed Installation	2000.00	EA	408	13,670	3,011	108	16,789	8.39
06037302 115	Pole Cutting Installation	4000.00	EA	924	30,958	6,820	0	37,778	9.44
06037302 116	Irrigation Operation-3 Yr	90.00	EA	2,712	90,863	20,017	0	110,880	1232.00
06037302 117	Weeding 3yr	36.00	EA	6,768	226,755	49,955	0	276,710	7686.38
06037302 118	Access Road Maintenance	880.00	TON	96	3,502	3,316	4,741	11,558	13.13
06037302 119	As-Built and Reports	1.00	JOB	0	0	0	0	12,000	12000.00
06037302 120	Reports	3.00	EA	0	0	0	0	24,000	8000.00
06037302 121	Cleanup	29268.00	EA	0	0	0	0	23,414	0.80
	TOTAL Mitigation	75.00	ACR	24,524	820,012	234,574	373,547	1,505,147	20068.63
	TOTAL Site			24,524	820,012	234,574	373,547	1,505,147	
	TOTAL Habitat and Feeding Facilities			24,524	820,012	234,574	373,547	1,505,147	
	TOTAL WILDLIFE FACILITIES AND SANCT.			24,524	820,012	234,574	373,547	1,505,147	
	TOTAL FISH AND WILDLIFE			24,524	820,012	234,574	373,547	1,505,147	
	TOTAL Mid-Valley Levee Restoration	1.00	EA	24,524	820,012	234,574	373,547	1,505,147	1505147
OVERHEAD								75,257	
SUBTOTAL								1,580,405	
HOME OFC								79,020	
SUBTOTAL								1,659,425	

** PROJECT DIRECT SUMMARY - (Unused) **

	QUANTITY	UOM	MANHRS	LABOR	EQUIPMNT	MATERIAL	TOTAL COST	UNIT COST
PROFIT							141,051	
SUBTOTAL							1,800,476	
BOND							18,005	
TOTAL INCL INDIRECTS							1,818,481	

APPENDIX H

ECONOMIC EVALUATION

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION
DESIGN MEMORANDUM

MID-VALLEY AREA

July 1995

PREPARED BY
ECONOMICS BRANCH, PLANNING DIVISION
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS

ECONOMIC EVALUATION

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION
DESIGN MEMORANDUM
MID-VALLEY AREA

TABLE OF CONTENTS

LIST OF TABLES

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION
DESIGN MEMORANDUM
MID-VALLEY AREA

TABLE OF CONTENTS (CONTINUE)

LIST OF FIGURES

LIST OF PLATES

SACRAMENTO RIVER FLOOD CONTROL SYSTEM EVALUATION
DESIGN MEMORANDUM - MID-VALLEY AREA

ECONOMIC EVALUATION

INTRODUCTION

The purpose of this report is to furnish flood damage data and provide information on the assumptions made and the procedures used in estimating average annual flood damages. Average annual damages and inundation reduction benefits were estimated for existing conditions of development. This analysis is based on a 50-year project life, October 1995 price levels, and an interest rate of 7.75 percent. Average annual damages and benefits are estimated in accordance with ER 1105-2-100. Assumptions and methodology used in the estimation of average annual damages under without- and with-project conditions are described in the following paragraphs. This report has been prepared to assist in the economic evaluation of risk and uncertainty.

FLOOD PLAIN DESCRIPTION

Flood plains were developed to identify areas subject to potential flooding due to project levee breaks. These flood plains were delineated into four areas: (1) Reclamation District 1500, which is encircled by the levee embankments of the Sacramento River, Tisdale Weir, and the Sutter Bypass; (2) Reclamation District 1001, bounded by the levee embankments of the Feather River, the Sutter Bypass, Natomas Cross Canal, and the East Side Canal; (3) an area encircled by levee embankments of the Sacramento River, Yolo Bypass, Knights Landing Ridge Cut, and the Colusa Basin Drainage Canal (this area also includes the community of Knights Landing); and (4) Reclamation District 1600, 827, 785, and 537, bounded by levee embankments along the Sacramento River, Sacramento Bypass and the Yolo Bypass. For convenience of analysis, Reclamation District 1600 (north of Interstate Highway 5) has been separated from Reclamation Districts 827, 785, and 537 (south of Interstate 5). Figure 1 shows the location of the four areas. Three of the areas are completely encircled by project levee embankments.

Table 1 shows the estimated population and the estimated acres analyzed in each area. A planimeter was used to measure the number of acres in each area. The land use within each area is predominantly agricultural. Population estimates were made from the California Department of Finance population projections.

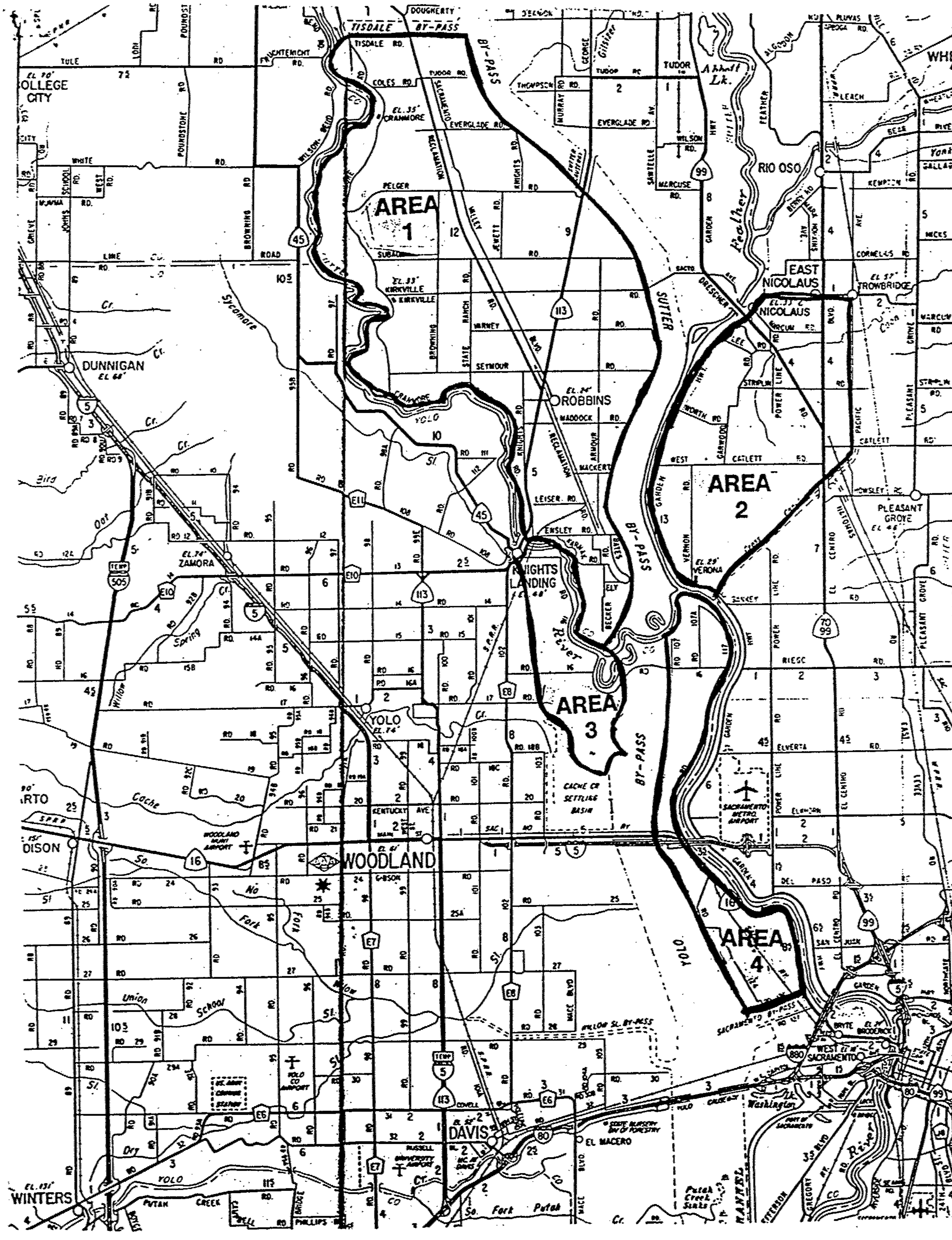

FIGURE 1 STUDY AREA

TABLE 1
POPULATION AND ACREAGE ESTIMATES

Area		Population	Acreage
1		1,240	48,462
2		750	29,355
3		850	2,212
4		240	13,055
	Total	3,080	93,084

FLOOD PLAIN INVENTORY

A flood plain inventory conducted early in 1995 identified the location, value, and number of structures within the land use categories of residential, commercial, industrial, public, and agriculture. For each structure, information was obtained on size (square feet), foundation height, type of construction, and number of floors. The value of properties for all structures and contents is shown in Tables 2 through 7, inclusive.

The value of each structure was estimated at replacement cost less depreciation. Replacement cost is the cost of physically replacing (reconstructing) the structure. Depreciation is that portion of the structure value that is diminished due to wear and age. Estimates of replacement cost were obtained from realtors, the county assessor's office, and Marshall and Swift appraisal handbook. Estimates of depreciation were obtained from Sacramento, Sutter, and Yolo County appraisers.

FLOOD DAMAGES

Flood damages were estimated based on depths and duration of flooding. Damages were estimated for the following categories: residential, commercial, industrial, public, agricultural, emergency costs, and automobiles.

Residential damages are physical damages to the structure (single-family, multi-family, and mobile homes) and contents (household items and personal property). Based upon discussions with local insurance agents, the value of residential contents is equal to 50 percent of the value (replacement cost less depreciation) of the structure. In accordance with EC 1105-8-1, costs were not estimated for the projects increase in household content value (affluence).

Commercial damages are estimated using the structure value and contents value. Contents include equipment and furniture, supplies, merchandise, and other items used in conducting business.

Industrial damages are damages which relate to fixtures and equipment, inventory, and structure.

Agricultural damages were estimated for non-crop losses to farm buildings and their contents. Agricultural damages to crops were also estimated since substantial acreage is in crop production. Crops grown in the study area are wheat, barley, sugar beets, tomatoes, melons, peaches, prunes, kiwi, pears, walnuts, pistachios, almonds, corn, and rice. Most of these aforementioned crops are planted annually in mid- to late spring (end of March and April and the beginning of May). The average damages per acre are shown in Tables 8 through 13, inclusive.

Public damages are those damages associated with the inundation of schools, churches, government offices and facilities, roads, parks, and bridges.

Emergency costs are the additional costs that are incurred during flood emergencies for evacuation and reoccupation, flood fighting, disaster relief, and increased police and fire protection. For purposes of this analysis, a cost of $40 per person per day was assumed.

Auto damages are sustained by automobiles located at private homes in the flood plains.

In addition, damages also occur as a result of traffic (highway, railroad, etc.) disruptions, levee breaks, and erosion of railroad embankments. A representative of the Union Pacific railroad indicated that extensive damages were sustained along its tracks during the 1986 flood. These damages totaled approximately $2 million and are for repair of the roadbed as well as for the extra costs of rerouting rail into the Sacramento Area. This rerouting of rail traffic included the leasing of trackage rights from the Southern Pacific Railroad.

TABLE 2

Value of Damageable Property*
(OCT. '95 Price Levels)
Area 1: (Robbins)
RD 1500

	# of Structures	Depreciated Structure Value ($1,000)	Contents Value ($1,000)	Combined Value ($1,000)
Houses	440	$14,271	$7,135	$21,406
Apts, Duplexes	2	101	50	151
Mobile Homes	64	405	202	607
Commercial	22	158	181	339
Industrial	12	2,406	2,406	4,812
Public Facilities	10	199	48	247
Levee Repair and Dewatering		6,600	0	6,600
Other Structures & Equipm't (Garages, Barns, Sheds, etc.)	484	2,212	2,312	4,524
Subtotal	1,034	$26,352	$12,334	$38,686
Emergency Costs				417
Automobiles				2,908
Totals				$42,011

*Excludes farmsteads and crops.

TABLE 3

Value of Damageable Property*
(OCT. ' 95 Price Levels)
Area 2: (Nicolaus & Verona)
RD 1001

	# of Structures	Depreciated Structure Value ($1,000)	Contents Value ($1,000)	Combined Value ($1,000)
Houses	264	$16,928	$8,464	$25,392
Apts, Duplexes	2	71	36	107
Mobile Homes	40	377	188	565
Commercial	11	190	197	387
Industrial	11	457	457	914
Public Facilities	2	603	302	905
Levee Repair and Dewatering		3,200	0	3,200
Other Structures & Equipm't (Garages, Barns, Sheds, etc.)	354	1,841	2,059	3,900
Subtotal	684	$23,667	$11,703	$35,370
Emergency Costs				276
Automobiles				1,919
Totals				$37,565

*Excludes farmsteads and crops.

TABLE 4

Value of Damageable Property
(OCT. ' 95 Price Levels)
Area 3: (Knights Landing)

	# of Structures	Depreciated Structure Value ($1,000)	Contents Value ($1,000)	Combined Value ($1,000)
Houses	318	$14,166	$7,083	$21,249
Apts, Duplexes	10	343	171	514
Mobile Homes	18	202	101	303
Commercial	15	2,886	4,326	7,212
Industrial	4	2,949	2,949	5,898
Public Facilities	16	470	167	637
Levee Repairs & Dewatering		4,000	0	4,000
Other Structures & Equipm't (Garages, Barns,Sheds,etc.)	29	118	132	250
Subtotal	410	$25,134	$14,929	$40,063
Emergency Costs				327
Automobiles				1,988
Totals				$42,378

*Excludes farmsteads and crops.

TABLE 5

Value of Damageable Property*
(OCT. '95 Price Levels)
Area 4
RD 1600; 827, 785, & 537

	# of Structures	Depreciated Structure Value ($1,000)	Contents Value ($1,000)	Combined Value ($1,000)
Houses	85	$2,710	$1,355	$4,065
Apts, Duplexes	0	0	0	0
Mobile Homes	13	102	50	152
Commercial	0	0	0	0
Industrial	4	202	201	403
Public Facilities	4	3,620	1,476	5,096
Levee Repair and Dewatering		4,400	(Traffic Disr.)	4,400
Other Structures & Equipm't (Garages, Barns,Sheds,etc.)	94	307	336	643
Subtotal	200	$11,341	$3,418	$14,759
Emergency Costs				88
Automobiles				551
Totals				$15,398

*Excludes farmsteads and crops.

TABLE 6

Value of Damageable Property
(OCT. ' 95 Price Levels)
Area 4: (North of HWY 5)
RD 1600

	# of Structures	Depreciated Structure Value ($1,000)	Contents Value ($1,000)	Combined Value ($1,000)
Houses	26	$963	$481	$1,444
Apts, Duplexes	0	0	0	0
Mobile Homes	2	17	8	25
Commercial	0	0	0	0
Industrial	0	0	0	0
Public Facilities *	1	857	738 (Traffic dlsr.)	1,595
Other Structures & Equipm't (Garages, Barns,Sheds,etc.)	30	112	116	228
Subtotal	59	$1,949	$1,343	$3,292
Emergency Costs				25
Automobiles				158
Totals				$3,475

* Excludes levee repair and dewatering.

TABLE 7

Value of Damageable Property
(OCT. '95 Price Levels)
Area 4; (South of HWY 5)
RD 827, 785, & 537

	# of Structures	Depreciated Structure Value ($1,000)	Contents Value ($1,000)	Combined ($1,000)
Houses	59	$1,747	$874	$2,621
Apts, Duplexes	0	0	0	0
Mobile Homes	11	85	42	127
Commercial	0	0	0	0
Industrial	4	202	201	403
Public Facilities*	3	2,763	738 (Traffic disr.)	3,501
Other Structures & Equipm't (Garages, Barns,Sheds,etc.)	64	195	220	415
Subtotal	141	$4,992	$2,075	$7,067
Emergency Costs				63
Automobiles				393
Totals				$7,523

*Excludes levee repair and dewatering.

TABLE 8

AREA 1
SUTTER COUNTY
1993
VALUE OF AGRICULTURAL PRODUCTION AND DAMAGES PER ACRE

LEADING CROPS	HARVESTED ACREAGE	YIELD	OUTPUT		VALUE PER UNIT	VALUE OF PRODUCTION	VALUE OF PRODUCTION PER ACRE	DAMAGE PER ACRE
Rice *	15,333	4.17	64,000	tons	$210	$13,440,000	877	58
Tomatoes	6,669	31.57	211,000	tons	43	9,073,000	1,360	292
Grain	5,293	3.41	18,000	tons	114	2,052,000	388	51
Safflower	5,027	1.18	6,000	tons	292	1,752,000	349	74
Beans (dry)	3,218	1,535	4,940,000	lbs	0.31	1,531,000	476	137
Leading crops	35,540					$27,848,000		
Other Crops	11,008							
Non-Agric	1,914							
Total Acres	48,462							

* Adjusted ASCS Target Price

TABLE 9

AREA 2
SUTTER COUNTY
1993
VALUE OF AGRICULTURAL PRODUCTION AND DAMAGES PER ACRE

LEADING CROPS	HARVESTED ACREAGE	YIELD	OUTPUT		VALUE PER UNIT	VALUE OF PRODUCTION	VALUE OF PRODUCTION PER ACRE	DAMAGE PER ACRE
Rice *	6,555	4.17	27,000	tons	$210	$5,670,000	865	58
Walnuts	3,056	1.77	5,400	tons	1,300	7,020,000	2,297	932
Grain	2,929	3.41	10,000	tons	114	1,140,000	389	51
Alfalfa	1,774	6.10	11,000	tons	95	1,045,000	589	340
Sugar Beets	1,363	31.39	43,000	tons	35	1,505,000	1,104	656
Leading crops	15,677					$16,380,000		
Other Crops	7,804							
Non- Agric	5,874							
Total Acres	29,355							

* Adjusted ASCS target price.

TABLE 10

AREA 3
YOLO COUNTY
1993
VALUE OF AGRICULTURAL PRODUCTION AND DAMAGES PER ACRE

LEADING CROPS	HARVESTED ACREAGE	YIELD	OUTPUT		VALUE PER UNIT	VALUE OF PRODUCTION	VALUE OF PRODUCTION PER ACRE	DAMAGE PER ACRE
Tomatoes	857	29.17	25,000	tons	$46	$1,150,000	1,342	290
Grain	289	2.03	587	tons	58	34,000	118	31
Safflower	178	0.93	166	tons	306	51,000	287	61
Melons, Etc	170	6.95	1,182	tons	211	249,000	1,465	315
Sugar Beets	112	23.76	2,661	tons	34	90,000	804	488
Leading crops	1,606					$1,574,000		
Other Crops	371							
Total Agric Crops	1,977							
Non-Agric	235							
Total Acres	2,212							

TABLE 11

AREA 4
YOLO COUNTY
RD 1600, 827, 785 & 537
1993
VALUE OF AGRICULTURAL PRODUCTION AND DAMAGES PER ACRE

LEADING CROPS	HARVESTED ACREAGE	YIELD	OUTPUT		VALUE PER UNIT	VALUE OF PRODUCTION	VALUE OF PRODUCTION PER ACRE	DAMAGE PER ACRE
Walnuts	2,805	1.39	3,899	tons	$1,162	$4,531,000	1,615	653
Grain	2,800	2.03	5,684	tons	79	449,000	160	31
Tomatoes	1,528	29.17	44,572	tons	46	2,050,000	1,342	290
Safflower	924	0.93	859	tons	306	263,000	285	61
Sudan	397	7.68	3,049	tons	79	241,000	607	128
Leading crops	8,454					$7,534,000		
Other Crops	2,613							
Total Agric Crops	11,067							
Non-Agric	1,988							
Total Acres	13,055							

TABLE 12

AREA 4
NORTH OF HWY 5
YOLO COUNTY
RD 1600
1993
VALUE OF AGRICULTURAL PRODUCTION AND DAMAGES PER ACRE

LEADING CROPS	HARVESTED ACREAGE	YIELD	OUTPUT		VALUE PER UNIT	VALUE OF PRODUCTION	VALUE OF PRODUCTION PER ACRE	DAMAGE PER ACRE
Walnuts	2,805	1.39	3,899	tons	$1,162	$4,531,000	1,615	653
Safflower	924	0.93	859	tons	306	263,000	285	61
Grain	494	3.30	1,630	tons	79	129,000	261	31
Sudan	397	7.68	3,049	tons	79	241,000	607	128
Tomatoes	232	29.17	6,767	tons	34	230,000	991	290
Leading crops	4,852					$5,394,000		
Other Crops	557							
Total Agric Crops	5,409							
Non-Agric	591							
Total Acres	6,000							

TABLE 13

AREA 4
SOUTH OF HWY 5
YOLO COUNTY
RD 827,785 & 537
1993
VALUE OF AGRICULTURAL PRODUCTION AND DAMAGES PER ACRE

LEADING CROPS	HARVESTED ACREAGE	YIELD	OUTPUT		VALUE PER UNIT	VALUE OF PRODUCTION	PRODUCTION PER ACRE	DAMAGE PER ACRE
Grain	2,306	3.30	7,610	tons	$79	$601,000	261	31
Tomatoes	1,296	29.17	37,804	tons	46	1,739,000	1,342	290
Sugar Beets	378	23.76	8,981	tons	34	305,000	807	488
Rice *	337	4.13	1,392	tons	180	251,000	745	49
Corn	335	5.21	1,745	tons	92	161,000	481	105
Leading crops	4,652					$3,057,000		
Other Crops	1,006							
Total Agric Crops	5,658							
Non-Agric	1,397							
Total Acres	7,055							

* Includes seed

DEPTH-DAMAGE RELATIONSHIPS

Depth-damage relationships for individual structures describe the probable damages that would occur for different depth of flooding. Table 14 shows the depth-damage relationships used in this evaluation. The 1988 Federal Insurance Administration depth-damage relationships were used for residential and public properties. Damage surveys conducted immediately after the February 1986 rainstorms of flood damaged structures in northern California, confirmed the reasonableness of these 1988 FIA depth-damage relationships.

The depth-damage relationships developed by the Tennessee Valley Authority (TVA) for the Department of Housing and Urban Development (HUD) in December 1969, Small Business Research for Flood Insurance Rate-setting, were used in estimating damages to commercial structures. For the Morrison Creek Investigation, California, interviews with owner and/or managers of commercial buildings established depth-damage relationships that are very similar to those in the cited HUD study. Therefore, the HUD depth-percent damage relationships are considered acceptable and reflect current damage information.

ELEVATION-DAMAGE RELATIONSHIPS

Due to the uncertainty of when, where, and how many levee breaks will occur within, adjacent to, and upstream of the study area for a particular flood event, a generalized methodology was developed to estimate the flood damages and inundation reduction benefits attributable to the proposed levee reconstruction. An elevation-damage relationship was developed for each area. Each elevation-damage relationship is based upon reservoir type flooding. For any levee break, floodwater would move into the area and flow by gravity in the direction of local drainage and pond behind the southernmost levee embankments of each flooded area. As flood depths and areas inundated increased, flood damages were determined for specific water surface elevations as if each elevation represented a lake with a horizontal water surface. For those areas completely encircled by levee embankments, the maximum elevation of flooding was the lowest levee crown elevation at which sedentary floodwater could begin to flow back out of the flooded area. At this elevation, additional levee failures are probable due to the high potential for loss of levee embankment material from wave action and overflowing floodwater.

TABLE 14

DEPTH-DAMAGE RELATIONSHIPS

Depth of Flooding on Ground	1] 1STY RES STR	1] 1STY RES CON	2] 2STY MULT/RES STR	2] 2STY MULT/RES CON	3] 1STY PUB MULT-RES STR	3] 1STY PUB MULT-RES CONT	4] MH STRUC	4] MH CON	5] BARNS STRUC	5] BARNS CON	6] COMM & IND STR	6] IND CON	6] COMM CON	7] 2STY COMM STRUC	7] 2STY COMM CON
.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
.5	2.6	.0	5.1	.0	7.7	.0	.0	.0	.0	.0	5.0	.0	.0	4.5	.0
.6	3.1	.0	5.5	7.4	8.3	11.3	.0	.0	.8	.8	5.2	2.4	.8	5.2	.8
1.0	5.1	.0	7.0	8.8	10.6	17.2	.0	.0	4.0	4.0	7.0	12.0	4.0	7.0	4.0
1.1	5.6	.0	7.4	9.1	11.2	18.4	.0	.0	4.8	4.8	7.2	14.4	5.4	7.2	5.4
1.5	7.7	.0	9.0	10.5	13.5	23.1	.0	.0	8.0	8.0	9.0	24.0	11.0	8.1	11.0
1.6	8.3	11.3	9.4	11.3	14.2	24.0	.0	.0	8.5	8.5	9.2	25.8	12.4	8.3	12.4
2.0	10.6	16.5	11.0	14.3	16.9	27.5	8.0	.0	10.5	10.5	11.0	33.2	18.0	9.2	18.0
2.1	11.2	17.6	11.4	14.9	17.6	28.1	11.5	3.2	11.0	11.0	11.2	35.0	20.1	9.4	20.7
3.0	16.9	27.5	15.5	20.3	23.5	33.3	43.0	26.6	15.5	15.5	15.5	50.8	45.0	11.1	45.0
5.0	27.6	35.8	21.0	30.6	29.3	38.8	73.0	64.1	30.0	30.0	24.0	73.2	73.0	16.1	73.0
7.5	40.7	44.9	26.0	43.9	42.8	49.9	79.5	76.6	55.0	55.0	35.3	82.5	80.0	22.0	80.0
9.0	43.4	52.3	32.0	51.8	44.5	57.4	82.0	78.8	68.5	68.5	41.9	82.5	80.0	25.0	80.0
10.0	44.5	57.3	36.0	55.9	45.6	59.9	85.0	80.7	75.0	75.0	46.5	82.5	80.0	28.0	80.0
11.0	45.6	59.9	38.0	57.9	46.7	59.9	90.0	82.9	81.5	81.5	51.0	82.5	80.0	30.0	80.0
12.5	47.1	59.9	38.0	57.9	48.3	59.9	98.0	82.9	85.0	85.0	60.0	82.5	80.0	35.5	80.0
13.0	47.7	59.9	38.0	57.9	48.6	59.9	100.0	82.9	85.0	85.0	60.0	82.5	80.0	36.5	80.0
15.0	49.5	59.9	38.0	57.9	50.0	59.9	100.0	82.9	85.0	85.0	60.0	82.5	80.0	43.2	80.0
16.0	50.0	59.9	38.0	57.9	50.0	59.9	100.0	82.9	85.0	85.0	60.0	82.5	80.0	45.9	80.0
17.0	50.0	59.9	38.0	57.9	50.0	59.9	100.0	82.9	85.0	85.0	60.0	82.5	80.0	48.0	80.0

Actual Depth of Flooding	8] 2STRY RES STRUC	8] 2STRY RES CONT
.0	.00	.00
1.5	.05	.00
1.6	.05	.07
2.0	.07	.08
3.0	.11	.14
4.0	.15	.20
4.5	.18	.23
5.0	.19	.25
5.5	.20	.28
6.0	.21	.30
7.0	.23	.36
8.0	.25	.42
8.5	.26	.44
9.0	.27	.47
9.5	.29	.50
10.0	.32	.56
11.0	.37	.58
11.5	.38	.58
12.5	.38	.58
13.0	.38	.58
14.5	.38	.58

Actual Depth of Flooding	9] Feed Mills STRUC	9] Feed Mills CONT
-1.0	.00	.00
.0	.00	.00
1.0	.00	.00
2.0	.00	.00
3.0	.00	.00
4.0	.20	.15
5.0	.23	.15
6.0	.27	.15
7.0	.30	.15
8.0	.33	.26
9.0	.37	.26
10.0	.40	.26
11.0	.43	.26
12.0	.47	.50
13.0	.50	.50
14.0	.53	.50
15.0	.57	.50
16.0	.60	.75

10] Depth of Flooding	10] Auto Damage
.90	.00
1.00	12.50
1.16	12.50
1.17	20.80
1.58	20.80
1.60	37.50
2.00	45.80
2.10	80.00
15.00	80.00

1] FEMA CURVES 1988 - 1.5' FOUNDATION - 1 STORY (SFR)
2] " " - 0.5' FOUNDATION - 2 STORY (MFR)
3] " " - 0.5' FOUNDATION - 1 STORY (MFR, PUBLIC)
4] HOLBROOK STUDY 1988 - 2.0' FOUNDATION - (MOBILE HOMES)
5] FORT WORTH STUDY - 0.5' FOUNDATION - (BARNS, SHEDS, AND FARM BLDGS)
6] TVA STUDY - 0.5' FOUNDATION (COMM & IND)
7] TVA STUDY - 0.5' FOUNDATION 2-STORY (COMM.)
8] FEMA CURVES 1988 - 1.5' FOUNDATION - 2-STORY (SFR)
9] FT. WORTH DISTRICT (GRAIN ELEVATORS)
10] LOWER SILVER CREEK/ WATERSHED, SOIL CONSERVATION SERVICE, 1983.

Elevation-damage relationships were estimated for each area and damage category in the flood plain (residential, commercial, and industrial structures, etc.) by relating depths of inundation and ground elevation to its corresponding depth-percent damage relationship. Damages were estimated for various depths of inundation in the flood plains. The damages of these relationships are also based on flood durations which are particularly critical in estimating losses to crops and orchards. Long durations of flooding are possible, especially if pumping is stipulated for removing floodwater from a given flooded area. The longer durations, however, did not significantly impact estimated flood damages.

The single event damages shown in Table 15 indicate the maximum potential flood damages for each of the four areas. The table shows that the maximum potential flood damages for Area 1 are $45.2 million, for Area 2 the maximum potential flood damages are $36.6 million, and for Area 3, the maximum potential flood damages are $27.4 million. For Area 4, the table shows maximum potential flood damages of $18.6 million. These maximum flood damages were used to estimate potential average annual damages and benefits.

POTENTIAL AVERAGE ANNUAL DAMAGES AND BENEFITS

Average annual damages were estimated under without- and with-project conditions. Under the without project condition, the potential levee failure recurrence intervals are shown in the tabulation below. The average annual damages and benefits for each of the four areas are summarized in Table 17.

POTENTIAL WITHOUT-PROJECT LEVEE FAILURE
RECURRENCE INTERVALS

Area 1	10 Year
Area 2	17 Year
Area 3	13 Year
Area 4	13 Year

LEVEE BREAK SCENARIO

Due to the complex nature of the Sacramento River Flood Control Project, a simplified scenario is used to determine how and when levees will break in each incrementally independent area as shown in Figure 1. There are four separate areas (Robbins, Knights Landing, Verona, and Elkhorn). Each area has multiple sites which have been identified as deficient and which had problems in passing the 1986 flood flows.

The proposed levee reconstruction in Phase III will correct the sites for seepage and stability problems as well as deficient levee crown elevations. A 3-day duration was used for design

TABLE 15

Single Event Damages By Category And Reach
(Oct. '95 Price Levels; in $1,000)

AREA 1 (RD 1500)	
Residential Structures	$7,242
Residential Contents	4,470
Farmsteads	2,336
Commercial	240
Industrial	3,429
Public (incl. levee repair & dewatering)	6,724
Agriculture	14,489
Emergency Costs	417
Automobiles	2,908
Other Structures & Equipment	2,924
Subtotal	$45,179
AREA 2 (RD 1001)	
Residential Structures	$7,964
Residential Contents	5,242
Farmsteads	2,976
Commercial	246
Industrial	590
Public (incl. levee repair & dewatering)	3,653
Agriculture	12,022
Emergency Costs	276
Automobiles	1,919
Other Structures & Equipment	1,757
Subtotal	$36,645
AREA 3 (Knights Landing)	
Residential Structures	$6,670
Residential Contents	4,421
Farmsteads	125
Commercial	4,803
Industrial	3,804
Public (incl. levee repair & dewatering)	4,319
Agriculture	862
Emergency Costs	327
Automobiles	1,988
Other Structures & Equipment	113
Subtotal	$27,432

AREA 4 & 5 (RD 1600; RD 827,785 & 537)

Residential Structures	$1,305
Residential Contents	852
Farmsteads	306
Commercial	0
Industrial	260
Public (incl. levee repair, dewatering & traffic disruption)	9,496
Agriculture	5,482
Emergency Costs	88
Automobiles	551
Other Structures & Equipment	289
Subtotal	$18,629
Total	$127,885
	$128,000

* Damages for farmsteads, commercial, industrial and public include structure and content values.

purposes. Stage and duration are important for defining a levee break scenario under existing or without project conditions.

Levee breaks that result from seepage or stability problems are dependent on the levee embankment and foundation soils, levee geometry, peak flood stages, and duration of peak flood stages. The phreatic water surface within the levee embankment is important in determining potential locations where levees could fail. Higher phreatic water surfaces at a specific location increase the potential for seepage and stability problems, and higher phreatic water surfaces are generally associated with coarser soil materials and longer flood durations.

Engineering judgement was used to determine where levees could break in each incremental area. The failure points are shown in Plate 1. During the 1986 flood, a number of sites exhibited seepage, and one site had water within 1 foot of the levee crown or 2 feet into the authorized freeboard. For most reaches of the Mid-Valley Area, the 1986 flood was the flood of record.

JUDGEMENTS OF EXISTING LEVEE RELIABILITY

Table 16 presents the Mid-Valley Area, Phase III, Sacramento River System Evaluation, Probable Nonfailure Points and Probable Failure Points for both pre-project and post-project conditions. This discussion is for the economic analysis only and, due to the complexities of the flood control system, is not related to future levels of flood protection.

ROBBINS AREA

The potential failure points for the Robbins Area consist of 13 sites along the right bank of the Sutter Bypass and three sites along the left bank of the Sacramento River. A representative location with numerous boils, Site 2, at Sutter Bypass mile 13.75 to 14.75 Right (71.2 miles from Yolo Bypass mile 0.0), adjacent to the State Highway 113 Bridge over Sutter Bypass, was chosen for the failure analysis for the Robbins Area based on performance in the 1986 flood. A large irrigation canal is located on the land side of Site 2. Numerous small holes in the sand lenses are located along the sand/clay interface where water has actively flowed under the levee in 1986 and 1996.

In 1986, a boil on the Sutter Bypass just east of the community of Robbins resulted in piping, lost much levee material, and had several feet of subsidence with multiple cracking. Only emergency flood fighting and construction of a 50-foot wide and 300-foot long waterside berm prevented complete levee failure.

The pre-project Probable Nonfailure Point (PNP) is estimated to be elevation 43.0 feet msl (15 percent chance of failure), and a pre-project Probably Failure Point (PFP) is estimated to be

elevation 46.0 feet msl (85 percent chance of failure). The top of levee is elevation 52.0 feet msl. During the 1986 flood, the maximum water surface elevation was 45.0 feet msl, about 1 foot below design. The state/frequency relationship for Site 2 is based on the gage at State Pumping Plant 2 in the Sutter Bypass.

The post-project PNP based on engineering judgment is at Sacramento River mile 111.0 Left. The post-project PNP is estimated to be elevation 47.0 feet msl (15 percent of failure), and the post-project PFP is estimated to be elevation 49.0 feet msl (85 percent chance of failure). The top of levee at Sacramento River mile 111.0 Left is elevation 51.5 feet msl. The gage on the Sacramento River near Wilkins Slough was adjusted for Sacramento River mile 111.0 Left.

KNIGHTS LANDING AREA

There are a number of potential failure sites in he Knights Landing Area. Along the Knights Landing Ridge Cut are 18,000 linear feet of deficient lever (Sites 12, 12A, and 13) with levee and foundation material composed of fat clays and organic material. Most of the slope failures are fairly shallow (up to five feet), but can occur at any time of the year. Along the Sacramento River are identified deficient sites at 87.1 to 87.3 Right (Site 9), 86.8 to 86.9 Right (Site 10), and 85.2 to 85.6 Right (Site 11); severe seepage was experienced during the 1986 and 1995 floods. The levee at these sites is composed of sand.

Under pre-project conditions at Sacramento River mile 87.1-87.3 Right (Site 9), the PNP I estimated to be elevation 38.0 feet msl (15 percent chance of failure). The top of levee at Site 9 is elevation 43.0 feet msl. The post-project break point is estimated to be at Sacramento River mile 88.3 Right wit a PNP elevation of 39.5 feet msl (15% chance of failure) and a PFP elevation of 42.0 feet msl. The tope of levee at Sacramento River mile 88.3 Right is elevation 43.0 feet msl.

The gage on the Sacramento River at Knights Landing was used to determine stage/frequency relationships for the Knights Landing area.

VERONA AREA

Potential failure sites for the Verona Area consist of four locations on the left levee of the Feather River below where the Sutter Bypass converges with the Feather River. Deficiencies are due to relative clean sand levees and foundation conditions which lead to seepage problems, instability, and the potential for levee failures due to piping. Several levee failures have occurred in the area and two of the three proposed reconstruction sites are prior levee break sites. The 1995 levee break occurred upstream of these sites near the town of Nicolaus.

For the Verona area, the site at Feather River mile 0.78 to 0.93 Left (Site 18) was used for the pre-project location most likely to experience levee failure. The 1986 flood water surface elevation at this location was at the design water surface and seepage occurred. The land side levee slope is over steepened, and a scour hole from a previous levee break at the site is located adjacent to the land side toe. In March 1995, the site exhibited heavy seepage which overfilled the pond and caused water to run across a road into fields at rates estimated at 5 cfs.

For purposes of this economic evaluation at Site 18 there is an estimated pre-project PNP elevation of 38.0 feet msl (15 percent chance of failure) based on the 1986 flood. A pre-project PFP elevation of 42.0 feet msl (85 percent chance of failure) was used at Site 18. The top of the levee is elevation 46.0 feet msl for Site 18.

The post-project PNP for the Verona Area at Feather River mile 2.5 Left is elevation 40.0 feet msl (15 percent chance of failure) and the post-project PFP is elevation 46.0 feet msl (85 percent chance of failure) at Feather River mile 2.5 Left. The post-project breakpoint levee crown is 49.0 feet msl at Feather River mile 2.5 Right.

The gage on the Feather River near Nicolaus was used to determine state/frequency relationships for the Verona Area.

ELKHORN AREA

In the Elkhorn Area, deficiencies have been identified at one site on the Sacramento River and 31,100 linear feet along the Yolo Bypass (Sites 15A and 15B).

For the Elkhorn Area, the site at Yolo Bypass 49.9 Left is representative of the pre-project condition. The January and February 1995 flood caused sloughing o several locations on the east levee of the Yolo Bypass, in the Elkhorn Area, on both the waterside and land side.

For the purpose of the economic evaluation at Yolo Bypass 49.9 Left, a pre-project PNP of elevation 29.0 feet msl (15 percent chance of failure) is based on the 1986 flood. A pre-project PFP of elevation 33.5 feet msl (85 percent chance of failure) was used. The tope of the levee is about elevation 36.0 feet msl at Yolo Bypass 49.9 Left.

The post-project location used was Yolo Bypass 52.5 Left. At Yolo Bypass 52.5 Left, the PNP is estimated to be elevation 32.5 feet msl (15 percent chance of failure) and the post-project PFP is elevation 35.0 feet msl (85 percent chance of failure). The post-project breakpoint levee crown is elevation 38.0 feet msl.

The gage on the Yolo Bypass near Woodland was used to determine state/frequency relationships in the Elkhorn Area.

TABLE 16

PNPs AND PFPs
MID-VALLEY AREA, PHASE III
SACRAMENTO RIVER SYSTEM EVALUATION

PRE-PROJECT (CHANCE/FAILURE)	POST-PROJECT (CHANCE/FAILURE)
ROBBINS AREA	
SITE 2	
SUTTER BYPASS 13.75-14.75R	**SACRAMENTO RIVER 111.0L**
(71.2 miles from mile 0.0 Yolo Bypass)	
PNP (feet) 43.0 MSL (15%)	47.0 MSL (15%)
PFP (feet) 46.0 MSL (85%)	49.0 msl (85%)
TOP OF LEVEE 52.0 MSL	**51.5 MSL**
gage: adjusted to Sutter Bypass mile 13.75 from gage at State Pumping Plant No. 2	gage; adjusted to Sacramento River mile 111.0 from Wilkins Slough, near Grimes
KNIGHTS LANDING AREA	
SITE 9	
SACRAMENTO RIVER 87.1-87.3 R	**SACRAMENTO RIVER 88.3R**
PNP (feet) 38.0 MSL (15%)	39.5 MSL (15%)
PFP (feet) 41.0 MSL (85%)	42.0 MSL (85%)
TOP OF LEVEE 43.0 MSL	**43.0 MSL**
gage: adjusted to Sacramento River mile 87.2 from Knights Landing	gage: adjusted to Sacramento River mile 88.3 from Knights Landing
VERONA AREA	
SITE 18	
FEATHER RIVER .78-.93 L	**FEATHER RIVER 2.5 L**
PNP (feet) 38.0 MSL (15%)	40.0 MSL (15%)
PFP (feet) 42.0 MSL (85%)	46.0 MSL (85%)
TOP OF LEVEE 46.0 MSL	49.0 MSL
gage: adjusted to Feather River mile .78 from Feather River at Nicolaus	gage: adjusted to Feather River at 2.5 from the Feather River at Nicolaus
ELKHORN AREA	
SITE 15A	
YOLO BYPASS 49.9 L	**YOLO BYPASS 52.5 L**
PNP (feet) 29.0 MSL (15%)	32.5 MSL (15%)
PFP (feet) 33.5 MSL (85%)	35.0 MSL (85%)
TOP OF LEVEE 36.0 MSL	**38.0 MSL**
gage: adjusted to Yolo Bypass 49.9 from the gage on the Yolo Bypass near Woodland.	gage: adjusted to Yolo Bypass 49.9 from the gage on the Yolo Bypass near Woodland.

RISK AND UNCERTAINTY IN ESTIMATING BENEFITS

The application of a risk analysis framework to flood damage reduction requires the identification, quantification, and evaluation of risk and uncertainty from various sources. Estimates of economic damages from flooding are frequently considered to be subject to significant errors. The problem is further exacerbated by the inherent uncertainties associated with hydrologic events and levee failures scenarios. One approach is to combine the various sources of risk and uncertainty to derive the overall risk and uncertainty associated with the stage-frequency curve. Analytically determining the joint risk or joint uncertainty from the underlying components is extremely difficult in many cases. An alternative approach employed in this analysis is to use Monte Carlo simulation to derive a numerical approximation for the analytical solution. This basically involves developing a risk-based flood damage model where the various parameters are described by probability distributions rather than as deterministic, single values. At each river stage these distributions are "sampled" and the resulting values of damages recorded. Multiple iterations allow the estimation of the distribution of damages at any stage. By re-running the model with multiple stages, a series of complete stage-damage curves with uncertainty were developed for this study.

The range and mean in average annual benefits for the four areas are presented in Table 17.

TABLE 17

Average Annual (Equivalent) Damages and Benefits
(October '95 Prices and 7.75% Interest Rate)

	Without Project Damages		Residual Damages		Benefits	
Area	Expected Mean	*Min.-Max.	Expected Mean	*Min.-Max.	Expected Mean	*Min.-Max.
1	2,313,500	2,251,900-2,375,100	584,000	552,000-616,000	1,729,500	1,699,900-1,759,100
2	1,016,500	979,900-1,053,100	382,200	358,000-406,300	634,300	621,900-646,800
3	952,000	919,500-984,400	395,400	374,400-416,400	556,600	545,100-568,000
4	553,600	534,400-572,700	323,200	308,200-338,200	230,400	226,200-234,500

*Two standard deviations (within 95% confidence limits)

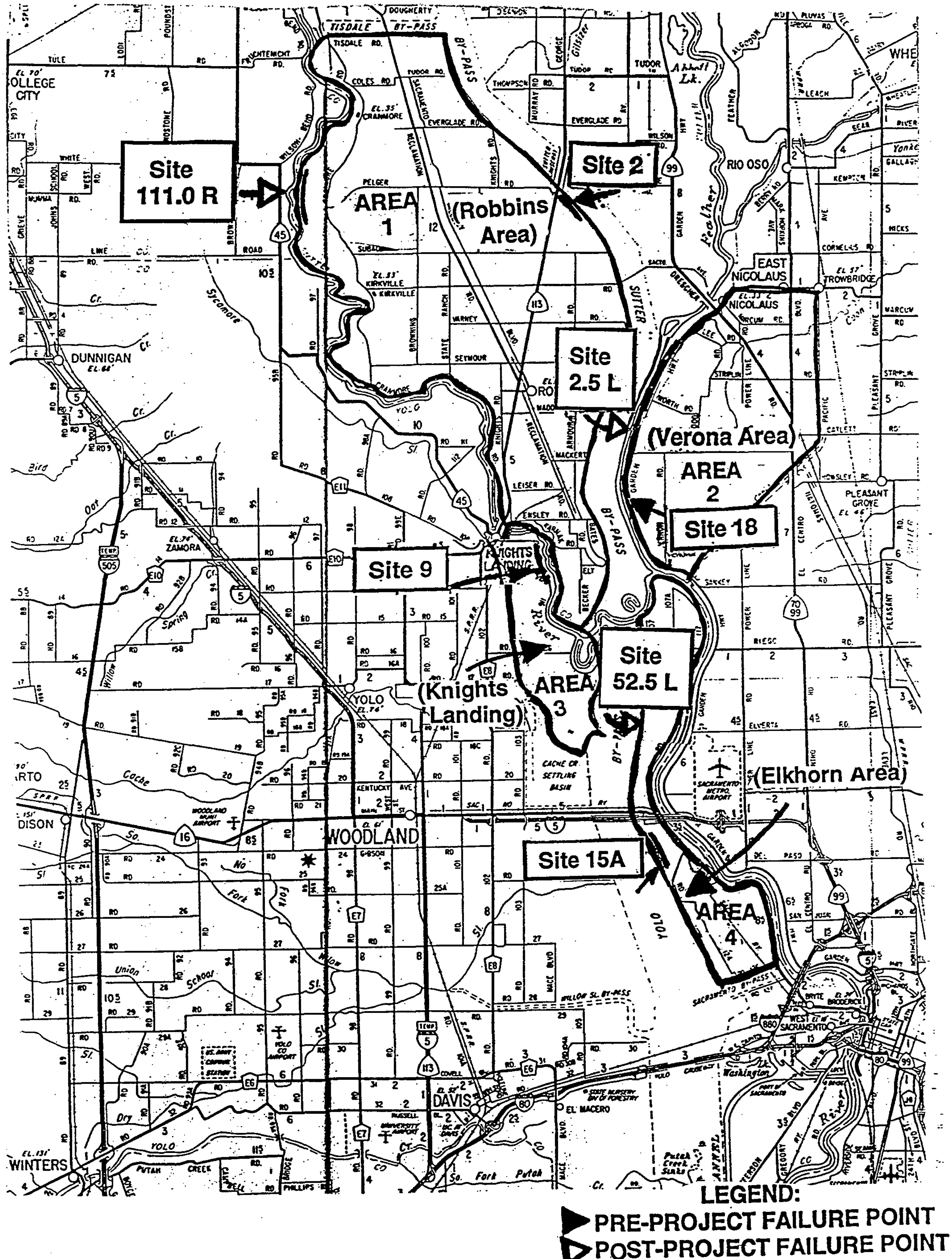

PLATE 1 STUDY AREA

APPENDIX I

ENGINEERING EVALUATION OF RISK AND UNCERTAINTY FOR ECONOMICS MID-VALLEY AREA, PHASE III, SACRAMENTO RIVER FLOOD CONTROL PROJECT, SYSTEM EVALUATION

INTRODUCTION

As instructed by the 1 March 1994 Headquarters 2d Endorsement of the Limited Evaluation Report submittal (CESPK-PD-S/29 Oct 93), this engineering report has been prepared to assist in the economic evaluation of risk and uncertainty.

LEVEE BREACHING SCENARIO

Due to the complex nature of the Sacramento River Flood Control Project, a simplified scenario is used to determine how and when levees will break in each incrementally independent area as shown in Figure 1. There are four separate areas (Robbins, Knights Landing, Verona, and Elkhorn Areas). Each area has multiple sites which have been identified as deficient and which had problems in passing the 1986 floodflows.

The proposed levee reconstruction in Phase III will correct the sites that have seepage and stability problems as well as deficient levee crown elevations. A 3-day duration was used for design purposes. Stage and duration are important for defining a levee breaching scenario under existing or without-project conditions.

Levee breaks that result from seepage or stability problems are dependent on the levee embankment and foundation soils, levee geometry, peak flood stages, and duration of peak flood stages. The phreatic water surface within the levee embankment is important in determining potential locations where levees could fail. Higher phreatic water surfaces at a specific location increase the potential for seepage and stability problems and higher phreatic water surfaces are generally associated with coarser soil materials and longer flood durations.

Engineering judgment was used to determine where levees could break in each incremental area. During the 1986 flood, a number of sites exhibited seepage, and one site had water within 1 foot of the levee crown or 2 feet into the authorized freeboard. For most reaches of the Mid-Valley Area, the 1986 flood was the flood of record.

JUDGMENTS OF EXISTING LEVEE RELIABILITY

Table 1 presents the Mid-Valley Area, Phase III, Sacramento River System Evaluation, Probable Nonfailure Points and Probable Failure Points for both pre-project and post-project conditions. This discussion is for the economic analysis only and, due to the complexities of the flood control system, is not related to future levels of flood protection.

ROBBINS AREA

The potential failure points for the Robbins Area consist of 13 sites along the right bank of the Sutter Bypass and three sites along the left bank of the Sacramento River. A representative location with numerous boils, Site 2, at Sutter Bypass mile 13.75 to 14.75 Right (71.2 miles from Yolo Bypass mile 0.0), adjacent to the State Highway 113 Bridge over Sutter Bypass, was chosen for the failure analysis for the Robbins Area based on performance in the 1986 flood. A large irrigation canal is located on the landside of Site 2. Numerous small holes in the sand lenses are located along the sand/clay interface where water has actively flowed under the levee in 1986 and 1995.

In 1986 a boil on the Sutter Bypass just east of the community of Robbins resulted in piping, lost much levee material, and had several feet of subsidence with multiple cracking. Only emergency flood fighting and construction of a 50-foot wide and 300-foot long waterside berm prevented complete levee failure.

The pre-project Probable Nonfailure Point (PNP) is estimated to be elevation 43.0 feet msl (15 percent chance of failure) and a pre-project Probable Failure Point (PFP) is estimated to be elevation 46.0 feet msl (85 percent chance of failure). The top of levee is elevation 52.0 feet msl. During the 1986 flood the maximum water surface elevation was 45.0 feet msl, about 1 foot below design. The stage/frequency relationship for Site 2 is based on the gage at State Pumping Plant 2 in the Sutter Bypass.

The post-project PNP based on engineering judgment is at Sacramento River mile 111.0 Left. The post-project PNP is estimated to be elevation 47.0 feet msl (15 percent of failure) and the post-project PFP is estimated to be elevation 49.0 feet msl (85 percent chance of failure). The top of levee at Sacramento River mile 111.0 Left is elevation 51.5 feet msl. The gage on the Sacramento River near Wilkins Slough was adjusted for Sacramento River mile 111.0 Left.

KNIGHTS LANDING AREA There are a number of potential failure sites in the Knights Landing Area. Along the Knights Landing Ridge Cut are 18,000 linear feet of deficient levee (Sites 12, 12A, and 13) with levee and foundation material composed of fat clays and organic material. Most of the slope failures are fairly shallow (up to five feet), but can occur at any time of

the year. Along the Sacramento River are identified deficient sites at 87.1 to 87.3 Right (Site 9), 86.8 to 86.9 Right (Site 10), and 85.2 to 85.6 Right (Site 11), severe seepage was experienced during the 1986 and 1995 floods. The levee at these sites is composed of sand.

Under pre-project conditions at Sacramento River mile 87.1-87.3 Right (Site 9) the PNP is estimated to be elevation 38.0 feet msl (15 percent chance of failure) and the PFP elevation is 41.0 feet msl (85 percent chance of failure). The top of levee at Site 9 is elevation 43.0 feet msl. The post-project break point is estimated to be at Sacramento River mile 88.3 Right with a PNP elevation of 39.5 feet msl (15% chance of failure), and a PFP elevation of 42.0 feet msl. The top of levee at Sacramento River mile 88.3 Right is elevation 43.0 feet msl.

The gage on the Sacramento River at Knights Landing was used to determine stage/frequency relationships for the Knights Landing Area.

VERONA AREA

Potential failure sites for the Verona Area consist of four locations on the left levee of the Feather River below where the Sutter Bypass converges with the Feather River. Deficiencies are due to relative clean sand levees and foundation conditions which lead to seepage problems, instability, and the potential for levee failures due to piping. Several levee failures have occurred in the area and two of the three proposed reconstruction sites are prior levee break sites. The 1955 levee break occurred upstream of these sites near the town of Nicolas.

For the Verona Area the site at Feather River mile 0.78 to 0.93 Left (Site 18) was used for the pre-project location most likely to experience levee failure. The 1986 flood water surface elevation at this location was at the design water surface and seepage occurred. The landside levee slope is over steepened and a scour hole from a previous levee break at the site is located adjacent to the landside toe. In March 1995 the site exhibited heavy seepage which overfilled the pond and caused water to run across a road into fields at rates estimated at 5 cfs.

For the purpose of this economic evaluation at Site 18 there is an estimated pre-project PNP elevation of 38.0 feet msl (15 percent chance of failure) based on the 1986 flood. A pre-project PFP elevation of 42.0 feet msl (85 percent chance of failure) was used at Site 18. The top of the levee is elevation 46.0 feet msl for Site 18.

The post-project PNP for the Verona Area at Feather River mile 2.5 Left is elevation 40.0 feet msl (15 percent chance of failure) and the post-project PFP is elevation 46.0 feet msl (85 percent chance of failure) at Feather River mile 2.5 Left. The post-project breakpoint levee crown is 49.0 feet msl at Feather River mile 2.5 Right.

The gage on the Feather River near Nicolas was used to determine stage/frequency relationships for the Verona Area.

ELKHORN AREA

In the Elkhorn Area deficiencies have been identified at one site on the Sacramento River and 31,100 linear feet along the Yolo Bypass (Sites 15A and 15B).

For the Elkhorn Area the site at Yolo Bypass 49.9 Left is representative of the pre-project condition. The January and February 1995 flood caused sloughing of several locations on the east levee of the Yolo Bypass in the Elkhorn Area on both the waterside and landside.

For the purpose of this economic evaluation at Yolo Bypass 49.9 Left, a pre-project PNP of elevation 29.0 feet msl (15 percent chance of failure) is based on the 1986 flood. A pre-project PFP of elevation 33.5 feet msl (85 percent chance of failure) was used. The top of the levee is about elevation 36.0 feet msl at Yolo Bypass 49.9 Left.

The post-project location used was Yolo Bypass 52.5 Left. At Yolo Bypass 52.5 Left the PNP is estimated to be elevation 32.5 feet msl (15 percent chance of failure) and the post-project PFP is elevation 35.0 feet msl (85 percent chance of failure). The post-project breakpoint levee crown is elevation 38.0 feet msl.

The gage on the Yolo Bypass near Woodland was used to determine stage/frequency relationships in the Elkhorn Area.

TABLE 1

PNPs AND PFPs
MID-VALLEY AREA, PHASE III,
SACRAMENTO RIVER SYSTEM EVALUATION

PRE-PROJECT (CHANCE/FAILURE)			POST- PROJECT (CHANCE/FAILURE)
ROBBINS AREA			
SITE 2			
SUTTER BYPASS 13.75-14.75 R			**SACRAMENTO RIVER 111.0 L**
(71.2 miles from mile 0.0 Yolo Bypass)			
PNP (feet)	43.0 MSL	(15%)	47.0 MSL (15%)
PFP (feet)	46.0 MSL	(85%)	49.0 MSL (85%)
TOP OF LEVEE 52.0 MSL			***51.5 MSL***
gage: adjusted to Sutter Bypass mile 13.75 from gage at State Pumping Plant No. 2			*gage: adjusted to Sacramento River mile 111.0 from Wilkins Slough, near Grimes*
KNIGHTS LANDING AREA			
SITE 9			
SACRAMENTO RIVER 87.1-87.3 R			**SACRAMENTO RIVER 88.3 R**
PNP (feet)	38.0 MSL	(15%)	39.5 MSL (15%)
PFP (feet)	41.0 MSL	(85%)	42.0 MSL (85%)
TOP OF LEVEE 43.0 MSL			***43.0 MSL***
gage: adjusted to Sacramento River mile 87.2 from Knights Landing			*gage: adjusted to Sacramento River mile 88.3 from Knights Landing*
VERONA AREA			
SITE 18			
FEATHER RIVER .78-.93 L			**FEATHER RIVER 2.5 L**
PNP (feet)	38.0 MSL	(15%)	40.0 MSL (15%)
PFP (feet)	42.0 MSL	(85%)	46.0 MSL (85%)
TOP OF LEVEE 46.0 MSL			*49.0 MSL*
gage: adjusted to Feather River mile .78 from Feather River at Nicolas			*gage: adjusted to the Feather River at 2.5 from the Feather River at Nicolas*
ELKHORN AREA			
SITE 15A			
YOLO BYPASS 49.9 L			**YOLO BYPASS 52.5 L**
PNP (feet)	29.0 MSL	(15%)	32.5 MSL (15%)
PFP (feet)	33.5 MSL	(85%)	35.0 MSL (85%)
TOP OF LEVEE 36.0 MSL			***38.0 MSL***
gage: adjusted to Yolo Bypass 49.9 from the gage on the Yolo Bypass near Woodland.			*gage: adjusted to Yolo Bypass 49.9 from The gage on the Yolo Bypass near Woodland.*

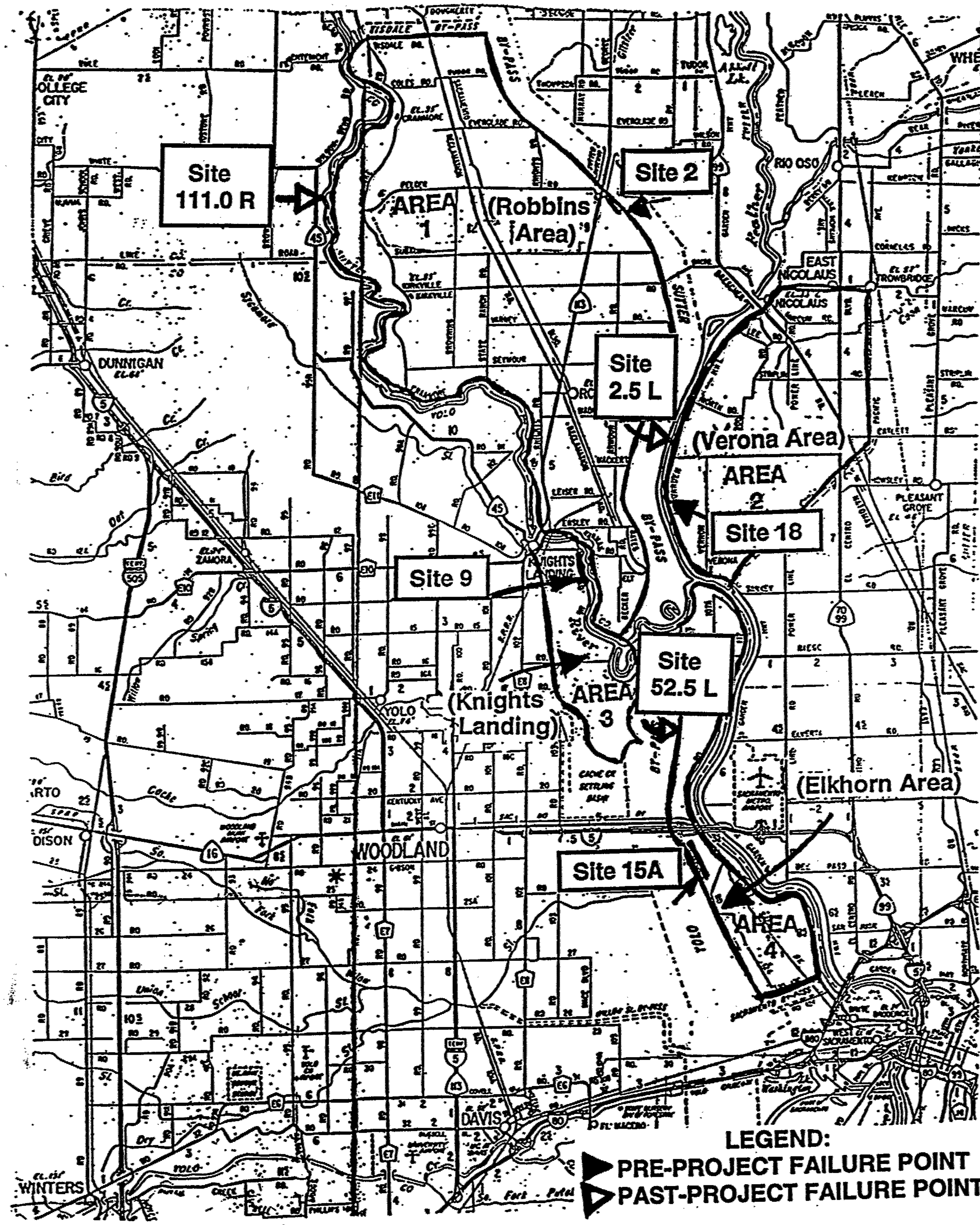

PLATE 1 STUDY AREA